Journal

OF

The Royal Society

OF

Western Australia.

Vol. XIV.
1927-1928.

CORRIGENDA.

Page 47.—Fourth line from bottom, for "back" *read* "black."

Page 49.—Line 15, for "less $\frac{O}{0{\cdot}68} = F$" *read* "less $\frac{O}{0{\cdot}86} = F$."

" Second line from bottom, for "10 to 3" *read* "3 to 10."

Page 56.—For the scale of the drawing "1 : 200" *read* "× 200."

by
FRED. WM. SIMPSON, Government Printer, Perth.

1928.

TABLE OF CONTENTS.

VOLUME XIV.

CONTENTS—*continued.*

PLATES.

TEXT FIGURES.

THE ROYAL SOCIETY OF WESTERN AUSTRALIA.

OFFICERS AND COUNCIL, 1927-1928.

Patron : HIS MAJESTY THE KING.

Vice-Patron : HIS EXCELLENCY SIR WILLIAM CAMPION, K.C.M.G., GOVERNOR OF THE STATE OF WESTERN AUSTRALIA.

President :

W. M. Carne, F.L.S.

Vice-Presidents :

R. D. Thompson, M.A., M.Sc. S. L. Kessell, M.Sc., Dip. For.

Retiring President :

A. Gibb Maitland.

Hon. Secretaries :

Natural Science : W. E. Shelton, B.Sc.

Physical Science : *A. A. Orton, B.A . M Sc

Treasurer :

P. M. Bonnerup, A.S.A.S.M.

Librarian :

L. W. Phillips, M.Sc.

Assistant Librarians :

L. Glauert, B.A., F.G.S. W. E. Campion.

Council :

F. E. Allum, I.S.O., G. Spencer Compton, B.Sc., A.I.M.M., C. A. Gardner, G. E. Nicholls, D.Sc., B. Perry, W.A. Saw, E. S. Simpson, D.Sc., J. F. Ward, M.A.

* Mr. Orton resigned during the year, and Mr. Phillips was appointed Joint Hon. Secretary, Mr. Glauert, Librarian, and Mr. W. E. Campion, Assistant Librarian.

LIST OF THE MEMBERS AS AT 1st JULY, 1928.

Honorary Members.

Bird, Mrs. A. M., The Old Farm, Albany, W.A.
Cooke, Professor W. E., M.A., F.R.A.S., The Observatory, Sydney, N.S.W.
Dakin, Professor W. J., D.Sc., F.L.S., F.Z.S., The University, Liverpool, England.
Diels, Dr. Ludwig, Director of Botanical Gardens and Museum, Berlin-Dahlem, Germany.
French, Charles, F.L.S., F.R.H.S., Government Entomologist, Melbourne, Victoria.
Hancock, W. J., M.Inst. C.E., M.Inst. B.E., D.Sc., C/o. Agent General's Office, Savoy House, Strand, London, England.
Michaelsen, Professor W., Zoological Institute, Hamburg, Germany.
Pritzel, Dr. E., Str. 4, Hans Sachs, Berlin-Lichderfelde, Germany.
Thynne, Major R., C/o. Marine Products, Ltd., Perth, W.A.

Corresponding Members.

Alexander, W. B., M.A., 15 Edridge Road, Croydon, England.
Cheel, Edwin, National Herbarium, Botanic Gardens, Sydney, N.S.W.
Clark, J., F.L.S., National Museum, Melbourne, Victoria.
Herbert, D. A., M.Sc., Department of Biology, University of Queensland.
Orton, A. A., B.A., M.Sc., University of Otago, Dunedin, New Zealand.

Ordinary Members.

Allen, F. B., M.A., B.Sc., The Technical School, Perth.
Allum, Miss Enid, Richardson Street, West Perth.
Allum, F. E., I.S.O., Richardson Street, West Perth.
Anderson, Joseph, 9 Mitchell Street, Mt. Lawley.
Baker, F. G., Technical School, Perth.
Barnes, Miss H. M., B.Sc., University of W.A., Perth.
Barnesby, A. J., "St. Margaret's" Frederick Street, Albany.
Baron-Hay, G., B.Sc. (Agr.), Department of Agriculture, Perth. *or* 64 John Street, Cottesloe.
Battye, J. S., LL.B., D. Litt., The Public Library, Perth.
Bennetts, H. W., M.V.Sc., Department of Agriculture, Perth.
Bennett, Dr. W. E., D.M.D., "Strathcona," Victoria Parade, Claremont.
Blackall, W. E., M.B., Ch.B., F.R.G.S., L.R.C.P., View Street, Cottesloe.
Blatchford, T., B.A., 2 Lyall Street, South Perth.
Bonnerup, P. M., A.S.A.S.M., A.M.P. Chambers, Perth.
Boultbee, G. F., Wagin.
Bowden, A. T., B.Sc., University of W.A., Perth.
Brearley, Major N., D.S.O., M.C., C/o. Airways, Ltd., A.M.P. Chambers, Perth.
Buckeridge, Walder, F.I.O.O., F.S.M.C., D.B.O.A., 263 Murray Street, Perth.
Burbury, D. C., A.S.M., Royal Mint, Perth.
Calanchini, M. J., Mines Department, Perth.
Campion, W. E., Forests Department, Perth.
Carne, W. M., F.L.S., Department of Agriculture, Perth.
Christie, W. B., C/o. Civil Service Club, Perth.
Clarke, E. de C., M.A., C/o. University, Perth.
Clifton, A. R. C., Department of Agriculture, Perth.
Clubb, Wallace, B.A., Education Department, Perth.
Compton, G. Spencer, B.Sc., A.I.M.M., 87 Second Avenue, Inglewood.
Coombe, Sir Thomas M. Kt., Prince of Wales Chambers, Perth.
Cosby, G. S., 13 Longroyd Street, Mt. Lawley.
Creeth, F. B., Avonmore Terrace, Cottesloe Beach.
Creeth, Miss M., 38 Wilson Street, West Perth.
Davis, Ray, M.Sc., Technical School, Perth.
Deans, G. E. M., 27 Holroyd Street, West Leederville.
Doye, A. G., Parker Street, Bassendean.
Dwyer, J. J., Box L882, G.P.O., Perth.
Edwards, Ernest W., Whitfield Street, Bassendean.
Ehrenreich, A., Ph.D. (Vienna), Present address not known.
Esson, A. G. D., M.A., Garrett Road, Bayswater.

LIST OF MEMBERS—*continued.*

ORDINARY MEMBERS—*continued.*

Feldtmann, F. R., Geological Survey, Perth.
Filmer, J. F., B.V.Sc., Stock Department, Fremantle.
Forsaith, Mrs. W. A., B.Sc., Hopetoun Street, South Perth.
Gardner, Charles A., Agricultural Department, Perth.
Gatherer, R. E., Royal Mint. Perth.
Garner, W. B., F.C.S., M.P.S., c/o. F. H. Faulding & Co., Murray Street, Perth.
Gibson, F. E., M.P.S., 142 High Street, Fremantle.
Glauert, L., B.A., F.G.S., The Museum, Perth.
Grasby, W. Catton, F.L.S., c/o. "West Australian," Perth.
Gray, H. J., M.B., B.Sc., 25 Richardson Street, West Perth.
Gray, H. R., B.A. (Oxon.), Commonwealth School of Forestry, Canberra.
Gulley, F. P., J.P., M.P.S., 262 Railway Parade, West Leederville.
Hadley, F. A. C., F.R.C.S., "Adelaide House," St. George's Terrace, Perth.
Hall, A. J., 9 Ruby Street, North Perth.
Hedges, W. N., Esplanade Mansions, Perth.
Hendry, Miss N. E., 18 Agett Road, Claremont.
Hislop, Dr. J. Gordon, M.B., Ch.B., M.R.C.P., 102 Cambridge Street, Leederville.
Holmes, H. D., Salvado Street, Cottesloe.
Hosking, J. S., B.Sc., 19 Bedford Avenue, Subiaco.
Jackson, Miss A., M.Sc., Forrest Street, Cottesloe.
Jackson, Horace B., Forrest Street, Cottesloe.
Joyner, A. E., 13 Rheola Street, West Perth.
Kessell, S. L., M.Sc., Dip. For., Forestry Department, Perth.
Kierath, A. R., c/o. Telephone Exchange, Murray Street, Perth.
Kirby, Harry, 830 Hay Street, Perth.
Klem, Carl A., Longroyd Street, Mt. Lawley.
Knapp, A., M.W.A.O.A., Barrack Street Perth, *or* 14 Altona Street, West Perth.
Knapp, Mrs. A., 14 Altona Street, West Perth.
Lapsley, R. G., B.Sc. (Agric.), 4 Judd Street, South Perth.
Larcombe, C. O. G., D.Sc., School of Mines, Kalgoorlie.
Law, R. O., Colin Street, West Perth.
Lefroy, J. Maxwell, Lands Department, Perth.
LeSouef, E. A., B.V.Sc., The Zoological Gardens, South Perth.
Limb, John M., A.A.C.I., 48 Fourth Avenue, Mt. Lawley.
Lotz, H. J., F.R.G.S., D.P.H., L.R.C., Perpetual Trustee Buildings, Perth.
Lovegrove, Dr. F., M.B., 9 Riley Road, Claremont.
Lovekin, The Hon. A., M.L.C., 9 Colin Street, West Perth.
Lukin, Mrs. M. R., Roberts Road, Subiaco.
Lunnon, J. H., D.B.O.A., F.I.O., Bruce Street, Nedlands.
Maitland, A. Gibb, Bon Accord, Melville Place, South Perth.
Maitland, Mrs. A. Gibb, Bon Accord, Melville Place, South Perth.
Male, Arthur, Broome, W.A.
Marr, H. V., A.A.C.I., c/o. Plaimar's Ltd., Perth.
McCallum, H., Department of Agriculture, Perth.
McDonald, Miss J., 22 Angelo Street, South Perth.
McMillan, The Hon. Sir Robert, K.C.M.G., C.J., View Street, Cottesloe.
McVicar, Douglas, Forestry Department, Perth.
Michelides, P., Forrest Place, Perth.
Moir, Miss M. B., M.A., D.Sc., The University, Perth.
Monger, Alex J., Perpetual Trustee Buildings, Box 373, G.P.O., Perth.
Montgomery, A., M.A., F.G.S., Mines Department, Perth.
Morgans, A. E., 81 St. George's Terrace, Perth.
Nathan, Sir C. S., Kt., c/o. Chas. Atkins & Co., 894 Hay Street, Perth.
Newman, L. J., F.E.S., Department of Agriculture, Perth.
Nicholls, Professor G. E., D.Sc., A.R.C.S., F.L.S., The University, Perth.
Nicholls, Mrs. G. E., Suburban Road, South Perth.
Nicholson, The Hon. John, M.L.C., Surrey Chambers, St George's Terrace, Perth.
Nunn, George M., L.S., 28 Victoria Avenue, Claremont.
Orton, E. C., B.Sc., Epson Avenue, Belmont Park.
Owen, Charles A., M.W.A.O.A., Forrest Place, Perth.
Paget, Owen F., M.D., 34 St. George's Terrace, Perth.
Paton, D. D., M.A., M.B., Ch.B., D.O., cr. King's Park Road and Colin Street, Perth.
Perry, B., Kenny Street, Bassendean.
Phillips, L. W., M.Sc., Technical School, Perth, *or* 10 Queen's Crescent, Mt. Lawley.
Pitchford, G. F., 47 Malcolm Street, Perth.

LIST OF MEMBERS—*continued.*

Ordinary Members—*continued.*

Plaistowe, Hugh, Forrest Street, Cottesloe.
Reed, Miss E. R. L., M.Sc., The University, Perth.
Riley, Most Rev. C. O. L., O.B.E., M.A., D.D., LL.D., V.D., Bishop's House, St. George's Terrace, Perth.
Rockett, H. P., A. Inst. M.M., Southern Cross.
Rolland, R. A., 29 Walker Avenue, West Perth.
Rosenstamm, B., 8 Bellevue Terrace, Perth.
Ross, Professor A. D., M.A., D.Sc., F.R.A.S., F.R.S.E., F. Inst. P., The University, Perth.
Saw, The Hon. A. J. H., M.L.C., O.B.E., N.A., M.D., F.R.C.S., 242 St. George's Terrace, Perth.
Saw. W. A., 4 Bellevue Terrace, Perth.
Sewell, H. C., 146 Suburban Road, South Perth.
Shelton, Mrs. M. A., 20 Kershaw Street, Subiaco.
Shelton, W. E., B.Sc., Modern School, Subiaco.
Shields, W. H., B.Sc., M. Inst. C.E., M.I.E.A., Swanbourne Terrace, Cottesloe Beach.
Simpson, E. S., D.Sc., B.E., F.C.S., Government Chemical Laboratory, Wellington Street, Perth.
Smith, Mrs. L. Russell, M.A., 112 Helena Street, Guildford.
Southern, B. L., A.A.C.I., Government Analyst's Office, Perth.
Stephenson, The Hon. H. A., M.L.C., 56 Ord Street, West Perth.
Sutton, G. L., Department of Agriculture, Perth.
Talbot. H. W. B., Mt. Wynne, *via* Derby.
Teakle, L. J. H., B.Sc. Ag. (W.A.), Ph.D. (Calif.), Department of Agriculture, Perth.
Thomas, Charles O. A., c/o. Sons of Gwalia G.M. Co., Ltd., Gwalia, W.A.
Thomas, F. J., Wilga Chambers, 158 Phillips Street, Sydney.
Thompson, James, B.E., M. Inst. C.E., "Rostrevor," Esplanade, Cottesloe.
Thompson, R. D., M.A., M.Sc., F.R.A.S., A. Inst. P., The University, Perth.
Thomson, John, c/o. Westralian Farmers, Perth.
Tilly, A. L., M.P.S., 728 Hay Street, Perth.
Unbehaun, A. C., Victoria Avenue, Claremont.
Wackett, W., c/o. F. H. Faulding & Co., Ltd., Murray Street, Perth.
Watkins, A. O., A.R.S.M., F.G.S., 67 Malcolm Street, Perth.
Webster, Dr. A., M.D., 229 St. George's Terrace, Perth.
Wells, J. E., Northwood Street, West Leederville.
Williamson, A. F., Public Works Department, Perth.
Wilsmore, Professor N. T. M., D.Sc., F.I.C., The University, Perth.
Wilson, R. C., B.Sc., B.E., "Lyndale," King Edward Street, South Perth.
Wilson, T. H., 31 Venn Street, West Perth.
Wood, J. A., 15 Chester Street, Subiaco.
Yeates, G. F., M.W.A.O.A., 37 Barrack Street, Perth.

Associate Members.

Adams, Dip. Ag. (W.A.), Agricultural College, Muresk.
Alexander, L., c/o. Falk & Co., Box B91, G.P.O., Perth.
Allen, T. G. B., Ormond College, Melbourne University, Melbourne, Victoria.
Anderson, Miss Henrietta, 9 Mitchell Street, Mt. Lawley.
Armstrong, Miss Florence, The Rectory, Victoria Park.
Atkins, R. W., Address not known.
Benham, Miss L., 9 Malcolm Street, Perth.
Bessell-Browne, Miss M. I., "Badjong," Anzac Terrace, Bassendean.
Campbell, J. G. C., B.Sc., Department of Agriculture, Suva, Fiji.
Campbell, W. D., A.K.C., F.G.S., A.M. Inst. C.E., L.S., Almaden, Chilagoa Railway, North Queensland.
Carne, Mrs. W. M., 7 York Street, South Perth.
Cleland, Professor J. B., M.D., Ch.M., The University, Adelaide.
Clarke, Mrs. E. deC., 8 Charles Street, South Perth.
Conning, Miss A. W., 55 Victoria Street, Bunbury.
Creeth, Mrs. F. B., Avonmore Terrace, Cottesloe Beach.
Cummins, Mrs. J. E., B.Sc., c/o. Madison Forests Products Laboratory, Madison, U.S.A.
Curlewis, Mrs. L. M., Lilian Street, Cottesloe.
Edmiston, Miss Margaret E., B.S., 14 Camelia Street, North Perth.
Elliot, H. G., Dip. Ag. (W.A.), 39 Marmion Street, North Perth.
Forman, F. G., B.Sc., Address not known.

LIST OF MEMBERS—*continued.*

ASSOCIATE MEMBERS—*continued.*

Galbraith, A. R., M. Inst, C.E.I., L.R.I.B.A.. A.M.I.E.A., City Engineer, Christchurch, New Zealand.
Gribble, Rev. E. R., c/o. A.B.M. Office, 571 Hay Street, Perth.
Hancock, Mrs. W. J., c/o. Neilson Hancock, Esq., Bank of New South Wales Chambers, Perth.
Hinckley, Miss C., 47 Forrest Avenue, East Perth.
Henderson, T. B., B.Sc., Grammar School, Guildford.
Hughes, T. R., F.C.S., 20 Tower Street, Leederville.
Hosking, Miss L., B.A., 13 Richardson Street, South Perth.
Jackson, Miss Nina Florence, Forrest Street, Cottesloe.
LeMesurier, C. J. R., 39 St. George's Terrace, Perth.
LeSouef, Miss Mildred, B.S., c/o. Zoological Gardens, South Perth.
Lipfert, O. H., The Museum, Perth.
Lovegrove, Mrs. F., 9 Riley Road, Claremont.
Lobstein, J. L., Wesley College, South Perth.
Lotz, Mrs. H. J., Hale House, St. George's Terrace, Perth.
Neville, A. O., Aborigines Department, Perth.
Newton, Miss E. A., c/o. W.A. Dairy Farmers Co-op, Stuart Street, Perth.
Paton, Mrs. D. D., c/o. Dr. Paton, Cr. King's Park Road and Collin Street, West Perth.
Pearson, H. E., B.A., B.Sc., Modern School, Subiaco.
Pelloe, Mrs. T., 78 King's Park Road, Perth.
Phillips, Mrs. L. W., 10 Queen's Crescent, Mt. Lawley.
Pirrell, W., 11 Carr Street, West Perth.
Prisk, Mrs. Olive, 24 Hamersley Road, Subiaco.
Prisk, Miss Joyce, 24 Hamersley Road, Subiaco.
Quilty, J. F., Government School, Tammin.
Richardson, K. C., M.Sc., The University, Sydney, N.S.W.
Robertson, Mrs. A. A., 1029 Wellington Street, Perth.
Ross, Mrs. A. D., B. Sc., 31 Ventnor Avenue, West Perth.
Roff, L. H., B.A. (Cantab.), The Grammar School, Guildford.
Rotenberg, Miss Dora, B.Sc., 8 Bulwer Street, Perth.
Serventy, D. L., 34 Onslow Road, Subiaco.
Shelton, Miss K. 20 Kershaw Street, Subiaco.
Shelton, Mrs, Wm. E., c/o. W. E. Shelton, Modern School, Subiaco.
Simpson, Mrs. E. S., "Carlingford," Suburban Road, South Perth.
Simpson, Miss Mary , B.Sc. (Ag.), Department of Agriculture, Melbourne, Victoria.
Steedman, H., 25 Fremantle Road, Victoria Park.
Stremple, Miss Edna M., B.Sc., Greenmount.
Sutton, Miss N. E., Ellesmere Road, Mt. Lawley.
Terrill, S. E., B.Sc., The University, Perth.
Thompson, Mrs. R. D., 61 Highway, Nedlands.
Tipping, Miss M., B.A., 79 Rookwood Street, Mt. Lawley.
Tothill, Miss E. M., 44 Ventnor Avenue, West Perth.
Williams, A. F., B.S.
Wood, W. E., Inspecting Engineer's Office, Railway Department, Perth.
Wright, A. R. L., L.R.I.B.A., T. & G. Chambers, St. George's Terrace, Perth.

STUDENT MEMBERS.

Andrewartha, H. G., The University, Perth.
Burvill, G., The University, Perth.
Hamilton, J., Technical School, Perth.
Hobson, R. A., The University, Perth.
Jeffrey, J., Technical School, Perth.
Parr, Miss M. E., The University, Perth.

Proceedings
of
The Royal Society of Western Australia.

Session 1928.

ANNUAL REPORT OF THE COUNCIL
FOR
THE YEAR ENDING 30th JUNE, 1928.

Ladies and Gentlemen,

Your Council begs to submit the following report for the year ending 30th June, 1928.

Membership.

On 30th June, 1928, 231 members are on the roll of whom 9 are honorary members, 5 corresponding members, 146 ordinary members, 65 associate members, and 6 student members. During the year 7 ordinary members and 8 associate members have been elected, while 15 ordinary members and 9 associate members have resigned.

Honorary Members.

Professor H. W. Michaelsen of the Zoological Museum, Hamburg, has been elected an Honorary Member of the Society in recognition of his valuable contributions to the fauna of South-Western Australia. Major Robert Thynne, of London, has been elected an Honorary Member as a zealous patron of science.

Corresponding Members.

Messrs. J. Clark, F.L.S., of the National Museum, Melbourne, and A. A. Orton, B.A., M.Sc., of the University of New Zealand, have been elected corresponding members of the Society.

The number of members and associate members for every year since the foundation of the Society is as follows, with the exception of the year 1921, in which no list of members was published in the Journal:—

Year.	Members.	Associates.	Total.
1914	...	...	112
1915	47	29	76
1916	59	19	78
1917	64	20	84
1918	64	19	83
1919	76	24	100
1920	75	27	102
1922	76	31	107
1923	89	40	129
1924	172	63	235
1925	161	72	233
1926	157	74	231
1927	154	66	220
1928	146	65	211

MEETINGS.

Twelve meetings of Council were held during the year.

EXECUTIVE OFFICERS.

During the absence abroad of Mr. Bonnerup, Mr. R. E. Gatherer carried out the duties of the Hon. Treasurer, and the Council desires to place on record its appreciation of Mr. Gatherer's services. Mr. Bonnerup is retiring from the office of Hon. Treasurer. The Council is indebted to him for his management of the finances of the Society during the current year.

Mr. A. A. Orton, Hon. Secretary for Physical Science, resigned from the Society in March owing to his having accepted an appointment in the University of New Zealand, and the Society has placed on record its appreciation of the services rendered by Mr. Orton during his terms of office as Hon. Secretary for Physical Science, and elected him a Corresponding Member. On Mr. Orton's departure, the Council made the following rearrangement of officers:—

Mr. L. W. Phillips—Hon. Secretary for Physical Science.

Mr. L. Glauert—Hon. Librarian.

Mr. W. E. Campion—Hon. Assistant Librarian.

FINANCES.

The Statement of the Society's Income and Expenditure during the 1927-28 session, which will be found appended, may be summarised briefly as follows:—

During the year, the total receipts on account of income, which includes the subsidy granted by the Government, amounted to £279 16s. 1d., being £14 2s. 2d. less than that received during the previous session. On the other hand, the current expenditure of the Society's year (leaving out of account the amount set aside as the nucleus of an Endowment Fund) amounted to £230 11s. 6d., being less than the revenue. The actual excess of receipts over expenditure during the year, therefore, amounted to £49 4s. 7d.

Parts 5 to 8 of Volume XIV., however, have been sent forward to the Printer, but this work being uncompleted, no account has yet been received for its cost. The expenditure (estimated at about £35), therefore, will have to fall upon next session's revenue, along with that for the completion of the volume, which it is estimated will cost an additional sum of about £60.

The grant received from the Treasury during the year was at the rate of £100 per annum, as in the preceding year, and the Council wishes to express its thanks to the Government for its subsidy. The heavy drain on the funds of the Society referred to in the last annual report has, however, led to delay in the publication of Volume XIII. It was not until September, 1927, that sufficient funds were in hand to permit the publication of this volume, which contains the proceedings and transactions for the year 1926-27. This is to be regretted, as such delay in publication of papers is apt to interfere with the claims of research workers for priority, as well as causing papers to lose something of their freshness.

Volume XIV., containing the proceedings and transactions for the year 1927-28, is well in hand, and it has been found possible to print all those contributions approved by the Council as suitable for publication in the Journal of the Society, and the completed volume should be ready for issue

early in the new financial year. The increased cost of printing causes the Council to hope that the Government may see its way to further increase its grant to ensure West Australian scientific workers having the opportunity of publishing in that Journal in which it is most appropriate that their papers should be published, namely, the Journal of the Royal Society.

During the year, Major Robert Thynne made a donation of £100 to the funds of the Society. This donation has been set aside to form the nucleus of an Endowment Fund, and has been placed on fixed deposit with the Society's Bankers for two years. The existence of this fund will enable the Society to give a guarantee of publication which it has not previously been possible to do.

Publications.

Having given careful consideration to the format of future issues of the Journal, the Council decided in the interests of efficiency upon an alteration to that of Royal Octavo, which is the size now adopted by the sister Societies of Queensland, Victoria and New South Wales, and one which the British Association for the Advancement of Science recently recommended as being that which best met with the requirements of the serial scientific publications of local societies.

The Council has to acknowledge its indebtedness to Mr. A. Gibb Maitland for undertaking the task of editing Volumes XIII. and XIV., and to express its high appreciation of the very capable manner in which this work has been carried out.

Centenary Celebrations.

In connection with the State Centenary to be celebrated next year, the Royal Society has been active in securing the co-operation of other scientific societies in preparing a scheme for submission to the Government for the housing of all the scientific societies in one common building. A report from the Centenary Sub Committee will be printed in the Proceedings in Volume XIV.

Delegates to Meetings of Scientific Associations.

Professor G. E. Nicholls and Miss E. R. L. Reed represented the Society at the meeting of the Australasian Association for the Advancement of Science held in Hobart in January of this year. Miss E. R. L. Reed, who represented the Society at the International Botanical Conference, Ithaca, New York, held in 1926, made a report to the Society in the form of an illustrated lecture before the April general meeting.

Library.

1. *Donations to the Library.*—The Council wishes to direct attention to the long series of the Quarterly Journal of the Geological Society of London, and of the Transactions of the American Institute of Mining Engineers, kindly presented by Mr. A. O. Watkins, F.G.S.

2. *Exchange List.*—During the year, five additions were made to the Exchange List, whilst three names were removed, giving a nett increase of two.

Analysis of the Exchange List.

Country.	Scientific Societies.	Government Depts.	Universities.	Museums, Libraries, etc.	Total.
Australia	9	12	4	12	37
England	4	1	1	5	11
South Africa ...	2	...	...	2	4
India	1	2	...	1	4
New Zealand ...	...	...	1	1	2
Canada	1	1	...	...	2
Europe	6	...	6	9	21
U.S.A.	2	1	11	12	26
South America ...	2	1	...	...	3
Java	...	1	...	...	1
	27	19	23	42	111

3. *Shelving and Binding.*—No money has been devoted to binding volumes or to provide additional accommodation in the way of shelving. Many volumes are at present stacked on the floor and valuable material is deteriorating through being handled in an unbound condition. The Librarians urge the setting aside of at least £50 in the near future to put an end to this state of affairs.

4. *Distribution of Volume XIII.*

Volume XIII. has been received from the printer and will be distributed early in the new year. It is proposed to make use of the International Exchange Service for the distribution of the Journal outside Australia. This should result in a considerable saving, as the postage to foreign countries is an expensive item.

GENERAL.

With a view to directing attention to scientific problems affecting the development of Western Australia, a series of lecurettes have been given at the general meetings throughout the year. A summary of these will be printed in the proceedings.

A discussion on the Natural Regions of Western Australia, which arose out of the paper by Mr. E. de Courcy Clarke, published in Volume XII. and read before the Australasian Association for the Advancement of Science meeting in Perth, 1926, resulted in the formation of a committee to deal with uniformity of nomenclature of the natural regions of Western Australia. The committee consists of Messrs. C. A. Gardner (Convenor), E. de Courcy Clarke, and L. Glauert.

REPORTS OF COMMITTEES.

Reports have been received from the following committees:—

(i) The Flora and Fauna Reserves Committee.
(ii) The Salinity in Soils Committee.
(iii) The Excursions Committee.
(iv) Science House Scheme Committee.
(v) The Natural Regions Committee.

These appear hereunder on page XVI., *et seq.*

W. M. CARNE,
President.

WM. E. SHELTON,
L. W. PHILLIPS,
Joint Hon. Secretaries.

ROYAL SOCIETY OF WESTERN AUSTRALIA.

YEAR 1927–28.

Statement of Receipts and Expenditure for the Year ended the 30th June, 1928.

	£ s. d.	£ s. d.
Balance at 1st July, 1927—		
Medal Fund ...	3 16 9	
General	83 18 5	
Cash	1 8 5	
		89 3 7
Subscriptions—		
1928–29	9 9 0	
1927–28	126 14 9	
1926–27	7 17 6	
1925–26	2 12 6	
1924–25	0 10 6	
		147 4 3
Government Grant, June, 1927, to May, 1928		100 0 0
Donation Major Thynne ...		100 0 0
Receipts from reprints ...		24 19 4
Interest		7 16 9
		£469 3 11

	£ s. d.	£ s. d.
Printing and Stationery ...		179 16 3
Petty Cash		30 16 8
Museum Trustees Fees ...		16 12 0
Rent Post Office Box		2 10 0
Excursion expenses		0 16 7
Balance—	£ s. d.	
Endowment ...	100 0 0	
Medal Fund ...	30 0 0	
General ...	107 5 3	
Cash in hand ...	1 7 2	
		238 12 5
		£469 3 11

It is estimated that the cost of completing Vol. XIV. of the proceedings will amount to about £95.

P. M. BONNERUP,
Hon. Treasurer.

Examined and found correct.

H. W. BENNETTS,
F. B. CREETH, } Hon. Auditors.

REPORTS OF COMMITTEES.

(i.) THE PRESERVATION OF FLORA AND FAUNA RESERVES COMMITTEE.

The personnel of the Committee remains the same as that obtaining during the currency of the year 1926-27, and which is set out on page xiv. of the Proceedings of the Royal Society, appearing in Volume XIII. of the Journal.

Since presenting its last report, the Committee has continued the work assigned to it, though no matter of moment relating to the fauna and flora reserves of the State has called for its active intervention during the currency of the Society's year.

The Committee recommends re-appointment as a Standing Committee of the Society, for its activities may be regarded as of a permanent nature.

(Sgd.) A. GIBB MAITLAND,
Convenor.

25th June, 1928.

(ii.) THE SALINITY IN SOILS COMMITTEE.

No formal meeting of the Committee has been held during the past twelve months, but the Hon. Secretary to the Committee has devoted a considerable amount of time in endeavours to trace from the data previously collected a definite relationship between the amount of combined chlorine carried down with the rain falling in various localities in Western Australia with the direction and velocity of the winds. Owing to the relative scantiness of the data available for places other than Perth, the establishment of any definite correlation has proved extremely difficult. The data for Perth are much more complete, and special thanks are due to Mr. E. B. Curlewis, Divisional Meteorologist for Western Australia, for the very full and detailed table of wind velocities and direction which he has compiled for the use of the Committee. An attempt is being made to combine Mr. Curlewis's data with the amount and salinity of the rainfall by means of graphical methods, and it is hoped that a report thereon will be ready shortly to submit to the Society.

(Sgd.) N. T. M. WILSMORE,
Chairman.

4th August, 1928.

(iii.) EXCURSIONS COMMITTEE.

During the 1927-28 session, the Excursions Committee decided to curtail the number of excursions and to make each more definite in aim. As a result, more detailed organisation devolved on the leaders with consequent improvement of both research and instructional phases of the Society's outings.

In the spring a botanical party, under the leadership of Mr. Gardner, paid a visit to the National Park. Hovea was reached by train, and during the walk back to Swan View, via the railway and Jane Brook, many specimens were collected and identified and discussed during the afternoon tea halt at Rocky Pool.

In May, a large party visited Statham's Quarry under the direction of Mr. Compton, who was assisted by Mr Glauert (zoology), and Mr. Gardner (botany). Owing to rain, chief attention centred on the work of the geological section, for under shelter, members were able to set out surveying instruments, carry out mineral tests on specimens collected and also inspect the rock crushing plant of the quarry. During the afternoon Mr. Compton led the party to the top of the Darling scarp and pointed out the chief physiographic features of the plateau edge and the coastal plain.

In June, Mr. Glauert led a party of thirty-three members along the beach from Leighton to Cottesloe. Owing to continued fine weather there was a paucity of marine specimens. Mr. Compton (geology) and Mr. Gardner (botany) directed attention to raised beaches and the flora of the sandhills and the algae and sea-grasses.

During the spring it is proposed to hold botanical excursions to suitable localities and to pay a visit to the scene of the Forestry Department's activities in the Mundaring district. The inspection of various metropolitan industrial centres is under consideration.

(Sgd.) WM. E. SHELTON,
Joint Hon. Secretary.

30th June, 1928.

(iv.) SCIENCE HOUSE SCHEME COMMITTEE.

In November, 1927, Mr. F. E. Allum placed before the Council certain proposals aiming at the establishment of a conveniently situated building for the housing of scientific and other societies. It was considered that the required accommodation could be provided appropriately in any building erected to form a Centenary Memorial.

As a result, a committee was appointed to confer with delegates from other societies, and two meetings have been called by the Royal Society.

At present investigations are being carried out along the following lines:

(1) To ascertain the probability of accommodation being secured in University buildings to be erected centrally in Perth, or in existing buildings at Irwin Street.

(2) To discover any building of historic interest which might be converted into a Centenary Memorial and which would adequately house the various societies.

(3) To study the development of any building scheme which in the future will aim at connecting the Public Library and the Museum.

Sub-committees are carrying out the above investigations with a view to submitting reports in July, 1928.

A further matter which has occupied the attention of the Committee is the co-operation of societies to organise a series of Centenary Exhibitions to be held during 1929.

(Sgd.) WM. E. SHELTON,
Joint Hon. Secretary.

30th June, 1928.

(v.) THE NATURAL REGIONS COMMITTEE.

Two meetings of the Committee have been held, one on the 15th June, and the other on the 22nd inst. The Committee, consisting of Messrs. E. de C. Clarke, L. Glauert, and C. A. Gardner, have compared the maps of Messrs. Clarke and Gardner, and generally have agreed upon the main points. A further meeting, anticipated for the near future, should prove sufficient to arrive at a mutual agreement. The boundaries of the three main divisions or provinces have been agreed upon, and all of the regions, with the exception of those of the South-West Province, where some difficulties have been encountered. A full report will be submitted when a satisfactory conclusion has been reached.

(Sgd.) C. A. GARDNER,
Convener.

30th June, 1928.

ABSTRACT OF PROCEEDINGS, 1926-27.

10th August, 1926.

Lecture.—"Canadian Wildflowers," illustrated by lantern slides and coloured plates, by Dr. J. G. Wright.

14th September, 1926.

Papers.—Two papers were read by Professor Ross:

(i) The Evolution of the new star "Nova Pictoris."

(ii) Some physical properties of "Manganese Steels."

12th October, 1926.

Exhibits.—Miss Armstrong and Mr. Williams exhibited a relief model of a portion of the Darlington District. Miss Armstrong detailed the steps in the preparation of the model and described instruments used in the obtaining of necessary data. Mr. Williams dealt with the various physiographical and geological changes which were evidenced by a study of the model. Professor Geissler took part in the ensuing discussion.

Mr. J. Clark exhibited a set of bull-ants (Sub. Fam. Ponerinae) and gave information about their primitive characteristics and habits.

Mr. A. Montgomery exhibited a gold specimen which to all appearances was of natural origin but actually formed by metallurgical treatment processes. He further gave an account of the iron deposit at Yampi Sound, and also of the Manganese leases to the north of Meekatharra. The description was illustrated by means of two relief models constructed by Mr. Lipfert.

Mr. Steedman exhibited a collection of flowers of West Australian Eucalyptus and Hibiscus.

9th November, 1926.

Lecture.—"The Story of the Forth Bridge," by Mr. A. T. Bowden. The lecture was illustrated by lantern slides, showing the design and process of building of the bridge. At the conclusion of the lecture the President referred to the geological work preliminary to the building of the bridge—a work in which he himself had taken part.

14th December, 1926.

Paper by Mr. H. R. Gray, M.A., Diploma Forestry, on "Western Australian Sandalwood," illustrated by lantern slides. The lecturer traced the development of the work of the Forestry Department in the re-afforestation and planting of Sandalwood in the Goldfields area.

Exhibits.—Dr. Simpson exhibited—

(1) a specimen of Kyanite-Staurolite Schist from Wattle Flat Cullalla, believed to be a highly metamorphosed product of granite;

(2) a set of Lithiophilite and its alteration products from Yandeyarra;

(3) a parallel intergrowth of Muscovite and Biotite from Yinnietharra;

(4) specimens of Microcline showing alteration to Albite.

Dr. Simpson also briefly outlined a modern American theory regarding the formation of pegmatite veins.

Mr. Carne exhibited a fruiting specimen of the Dry-Rot fungus *Merulius lachrymans*, a very rare fungus in Australia, this being the first definite record from Western Australia.

Mr. Steedman exhibited five flowering specimens of native flora.

Mr. Hughes exhibited the essential oil of *Phebalium argenteum*.

8th March, 1927.

Exhibits.—Mr. Hall showed numerous dried specimens and water-colours of plants collected by him during a visit to the Porongorups.

Mr. Carne exhibited apples showing "bitter pit," a disease which caused considerable loss, but concerning the origin of which little or nothing was known. Lithiasis in pears (also exhibited) was probably closely allied to "bitter pit" in apples.

Mr. Steedman showed specimens of flowers and fruits of *Monstera deliciosa;* a flowering Northern Territory tree (*Stenocarpus Cunninghamii*), and foliage and fruit of the Queensland Black Chestnut (*Castanospermum australis*).

Mr. Shelton exhibited (a) Australites of various forms, one with a curious spiral marking; (b) Iron pyrites in rounded form (from Bulong); (c) Limonite pseudomorphs of iron pyrites crystals: (d) Garnets from Macdonnel Ranges.

12th April, 1927.

Paper.—A paper on "Fifty new Species and Six new Varieties of Acacias," by J. H. Maiden and E. W. Blakely, was communicated to the Society by Mr. W. M. Carne. Mr. Carne explained that the paper was the Western Australian portion of unpublished work of the late J. H. Maiden, completed after his death by his assistant, Mr. F. W. Blakely.

Exhibits—

(1) Mr. Sutton exhibited standard f.a.q. samples of wheat. He explained the present method of fixing the standard and also described a scientific method of grading and standardising wheat which it was hoped would ultimately replace the more or less arbitrary f.a.q. standard.

(2) Mr. Glauert exhibited (a) a specimen set of insects from Ceylon, including the bird-eating spider, leaf insects, and millipede; (b) a model of a brown snake from Western Australia (Gwardah); (c) house building Rat, from South Australia; (d) skull of Barcoo Balby, from near Wiluna, Western Australia; (e) specimens of foraminafera.

(3) Mr. W. M. Carne exhibited specimens of *Lysurus australiensis*, a phalloid fungus very common in lawns around Perth in the autumn or late summer after rains.

(4) Mr. Shelton exhibited a young pine seedling and pointed out the absence of root hairs, and referred to the action of a fungus which was believed to function as root hairs of other plants.

(5) Mr. Steedman exhibited a number of specimens of Banksia cones, pointing out that the size of the cone was no criterion of the size of the tree; also young plants and fruit of the zamia palm.

(6) Mr. Compton exhibited specimens of Arbitolites from the raised beaches of Waterman's Bay.

10th May, 1927.

Address.—An illustrated address on the work of the Magnetic Observatory at Watheroo was given by Mr. F. W. Wood, B.Sc.

Exhibits.—Miss Creeth exhibited colour variations of the flowers of the flowers of the *Banksia Menziesii.*

14th June, 1927.

Papers.—The following papers were read:—

(1) "Contributions to the Mineralogy of W.A.," by Dr. E. S. Simpson, containing descriptions of eight minerals, four from Wodgina, and one each from Roy Hill, Londonderry, Kalgoorlie, Murchison Downs, and Mt. Magnet, the latter two being meteoric irons.

(2) "The Helminths of W.A.," by H. W. Bennetts, B.V.Sc., listing and describing hitherto recorded and unrecorded species.

(3) "Contribution No. 6 to the Flora of W.A.," by C. A. Gardner, adding 7 new species, but deleting 11.

Lecturette by Mr. L. W. Phillips on Fermentation.

Exhibits.—Mr. Steedman showed flowering specimens of W.A. plants.

Mr. Shelton exhibited unusual forms of australites and iron pyrites crystals.

ABSTRACT OF PROCEEDINGS, 1927-28.

12th July, 1927.

Presidential Address.—The retiring president, Mr. Gibb Maitland, delivered his presidential address on "The Volcanic History of Western Australia."

9th August, 1927.

Lecturette.—"The Problem of Forest Waste," by Professor N. T. M. Wilsmore. The utilisation of waste timber as such and the possibilities of converting it into paper pulp, artificial silk, alcohol and other commodities were explained. He considered the utilisation of saw-dust as a fuel, both directly and in the form of briquettes, and in the manufacture of artificial wood, was discussed.

Papers.— Mr. H. W. Bennetts read a paper on "Contributions to our Knowledge of the Poison Plants of Western Australia."

Mr. L. W. Phillips communicated a paper, "A Preliminary Note on the Chemistry of the Concrete Otto of Boronia Megastigma," by A. R. Penfold.

Exhibits.—Mr. Glauert exhibited specimens of gecko lizards, *Gymnodactylus miliusii* and *Nephrurus asper.* The latter, a dangerous species, apparently imitated the former.

Mr. Steedman exhibited various flowering specimens of Eucalyptus, Wattle and other native flowering plants, and also a specimen of Rust Gall on Wattle.

13th September, 1927.

Lecturette.—Mr. G. L. Sutton, Director of Agriculture, enumerated and discussed the problems confronting the pastoralists of Australia. In the lecturette, and considerable discussion which ensued, Mr. Sutton presented a wide range of facts concerning the development of Australia's flocks and herds and the researches past, present and proposed, which aimed at the improvement of the animals and elimination of disease, pests, and the effect of drought.

Paper.—Mr. W. M. Carne read a paper entitled "Additions to the Plant Diseases of Western Australia."

Exhibits.—Dr. Simpson showed some lithia mica from Tabba-Tabba tin field. Unusual features were the globular appearance, due to the plates being rounded instead of flat, and the rich thallium content (about ten times the normal).

Mr. Glauert exhibited (a) rounded objects, dark in colour and about an inch in diameter, collected in the North-West by Dr. Simpson. They were identified as cocoons of a black weevil of the genus Leptos. The mineral composition indicated that the specimens were fossilised. (b) Skin of mallee hen reared in captivity at Kellerberrin. (c) A collection of local cephalopods, including shells of nautilus, spirula, sepia and paper nautilus.

Mr. Steedman displayed a fine collection of palm fruits, and also Australian flowers, including a specimen of the New South Wales waratah.

11th October, 1927.

Lecturette by Mr. S. L. Kessell on "Some Problems of Sylviculture in areas of low summer rainfall." Mr. Kessell mentioned specially the problems of natural regeneration and growth of Jarrah, Tuart, Mallet, and Sandalwood, and also dealt with the question of summer fires and the introduction of exotics.

Exhibits.—Mr. Carne. (a) Stone-like false sclerotia of a polyporoid fungus, *Polyporus basilapiloides* (McAlp. and Tepper). (b) Oats attacked by *Ophiobolus cariceti*, the pathogen of take-all of wheat (a first record in oats in Western Australia). (c) Wheat attacked by *Wojnowicia graminis*, one of the pathogens of foot-rot.

Mr. Shelton. Spherical masses of iron pyrites embedded in a graphite matrix, from Bulong.

Mr. Steedman. Some growing specimens of the Albany Pitcher Plant, and also a collection of flowering eucalypts.

Mr. Gardner. Rare plants from the Southern Cross-Comet Vale area. The plants exhibited striking xerophytic modifications. During his remarks, Mr. Gardner referred to the climatic cause of the sharp demarcation of the mulga flora.

8th November, 1927.

Lecturette.—"The Problem of Food Storage," by Mr. Phillips. The author dealt specially with the problems connected with the overseas marketing of butter, cheese, meat, fruit, wheat, and eggs.

Exhibits.—Mr. Glauert showed some masses of reef-building coral which had been unearthed at Bunbury and referred to in the Press as "the Bunbury whale."

Mr. Steedman exhibited seeds of an Asclepiad, *Stephanotis floribunda*, and flowering specimens of a number of indigenous plants.

Mr. Carne exhibited Flat-weed attacked by *Puccinia hypochaeridis*, Oud. (a first record for Western Australia), and mentioned that the rust was not a control, for the weed seeded before being killed by the fungus.

13th December, 1927.

Lecturette by Mr. G. Spencer Compton on the Metallurgy of Gold, with special reference to problems in Western Australia. In the course of an exhaustive treatment of his subject the lecturer dealt with the rise and fall

of the industry, and with the various stages in the process of extracting gold, and in particular the processes of crushing, roasting, and subsequent treatment, and the disposal of the residues.

Exhibits.—Mr. Steedman exhibited a number of specimens of flowering shrubs and trees.

13th March, 1928.

Symposium.—"The Natural Regions of Western Australia," by Mr. E. de C. Clarke, Mr. C. A. Gardner, and Mr. L. Glauert.

Exhibits.—Mr. Steedman exhibited a flowering specimen of *Eucalyptus erythrocorys.*

17th April, 1928.

Lecturettes.

(a) The Fourth International Botanical Congress at Ithaca, N.Y., by Miss E. R. L. Reed.

(b) "Imports, Exports and Public Debts," by Mr. Allum.

Paper by Mr. J. Clark, comm. by Mr. Glauert, "Australian Formicidae."

Exhibits.—Mr. Steedman exhibited flowering Sturt's Desert Pea (*Clianthus speciosus*), and fruits of *Podocarpus Drouyniana.*

8th May, 1928.

Papers.—"Fauna of Western Australia, Part I.," by L. Glauert. "Contributions to the Mineralogy of Western Australia, Series III.," by Dr. E. S. Simpson. "Further Contributions to Animal Parasites of Western Australia," by Mr. H. W. Bennetts.

Exhibits.—Mr. Steedman exhibited: A fungus *Polyporus eucalyptorum* from Tuart trees. Two spiders, one red and black and the other grey (not determined).

12th June, 1928.

Paper by Mr. C. A. Gardner: "Contributions to the Flora of Western Australia, No. 7," describing five new species.

Lecturette by Mr. H. A. Pittman, B.Sc. (Ag.): "Tomato Blight or Spotted Wilt," illustrated by drawings of diseased plants dealing with experiments to determine the insect carrier of the disease and shown to be the common thrips, *Thrips tabaci.*

Exhibits.—Mr. Glauert: The skull of a rare dolphin from Capel, the second to be acquired by Australian museums.

Mr. Gardner: The new orchid recently discovered at Corrigin.

Mr. Steedman: Zamia palm seedlings with special swollen roots containing *Cyanophyceae* and bacteria. Flowering specimens of Acacia spp. *Hakea laurina*, and *Templetonia retusa.*

AN OUTLINE

OF

THE HISTORY OF PHYTOPATHOLOGY

With special reference to

ITS DEVELOPMENT IN AUSTRALIA.

PRESIDENTIAL ADDRESS

By

W. M. CARNE, ESQ., F.L.S.

(Delivered on the 10th July, 1928; Published 17th October, 1928.)

INTRODUCTION.

Phytopathology, Plant Pathology, Vegetable Pathology, or, as it is known in Great Britain, Applied Mycology, is the study of plant diseases and their control. It is essentially an economic study and must be clearly distinguished from Mycology, the study of fungi.

The recognition of disease in plants dates back to the earliest records. For instance, in the Bible we find a number of references such as "If there be in the land famine; if there be pestilence, blasting, mildew, locust, or if there be caterpillar . . . ." (Kings I., viii., 37.)

It must be understood that by "disease" we mean any condition of a plant which prevents the development, either in quality or quantity, of the growth which is possible and desired for such a plant. It must also be understood that diseases coming within this definition are in many cases of little consequence to the plant functions of life and reproduction, though of great consequence to the grower as a result of their effects on the plant products he aims at securing.

Diseases are of varied origin. They may arise from hereditary defects, from unsuitable growth conditions, from injury and from parasitism. Convenience, and the enormous field of Zoology, have lead to plant troubles caused by animals, particularly insects, being regarded as the field of the Economic Zoologist or Economic Entomologist. In its modern conception, therefore, Phytopathology deals with all diseases other than those of animal origin. It must be admitted that diseases of nematode origin are frequently regarded as in the sphere of Phytopathology, and that in other cases, more especially in the virus diseases, entomology and pathology overlap.

For the purpose of this address Whetzel's "An Outline of the History of Phytopathology" (15), the only book on the subject, has been freely utilised. With modifications and additions this author's classification of Eras and Periods has been adopted.

The Ancient Era.

(From the first records down to the end of the Fifth Century.)

Writers of this Era, which falls naturally into the Hebraic, Greek and Roman Periods, recognised the part played by environmental factors, such as frost and drought, in diseases causation. They recognised also the facts of susceptibility and of resistance to disease. Rusts of cereals in particular received attention, but while such philosophers as Theophrastus and Pliny noted the association of epidemics with seasonal and environmental conditions, in general, superstition prevailed. The farmer of the day besought his gods to protect his crops, and attributed disease to evil influences.

The Dark Era.

(From the fall of the Roman Empire until the beginning of the Seventeenth Century.)

During this long and unproductive period little was added to our knowledge of plant diseases. The one outstanding figure, according to Whetzel, was the Arabian writer, Ibn-el-Awam, who studied and described many diseases of grape vines and trees at Seville in Spain in the Tenth Century. The revival of learning in the Fourteenth and Fifteenth Centuries led to the study of the ancient Greek and Roman philosophers. The outlook of students was, however, one of slavish acceptation of authority and the observations and theories of Theophrastus and Pliny, in particular, as to plant diseases were blindly accepted.

Autogenetic Era.

(From the Seventeenth Century to the middle of the Nineteenth Century.)

(a) *The Renaissance Period.* (The Seventeenth Century.)

This period marked a revival of interest in the study of diseases, particularly by the more intelligent growers of plants. Methods, more or less successful, were devised for the control of diseases. In 1660 at Rouen in France, we hear of the first legislative enactment in regard to plant diseases. A decree ordered the destruction of barberry bushes on the ground that they were in some way associated with epidemics of wheat rust. The experimental proof of this observation had to wait until the middle of the Nineteenth Century when the fact that wheat rust (*Puccinia graminis*) required in Europe the barberry (*Berberis communis*) as an alternative host was demonstrated by the brilliant work of the Tulasne brothers in France.

No great contribution to our knowledge of the causes of disease was made in this period, and the ideas of students were still dominated by the philosophies and superstitions of the past.

(b) *The Zallingerian Period.* (Eighteenth Century.)

This period was marked by the co-existence of two points of view amongst writers on plant diseases—the philosophic and the practical. The influence of the revival of interest in biologic classification which, culminating in the Linnean System of nomenclature in 1753, laid the foundation of modern Taxonomy, strongly influenced philosophic writers. Zallinger in his "De morbis plantarum" classified diseases into five groups on symptomatic grounds. The theories of causation accepted by Zallinger and his contemporaries were largely those of the ancient philosophers. Fungi assoc-

iated with disease he regarded as the products, rather than the causes of diseases. On the practical side the period was marked by the production of books for the practical grower in which emphasis was laid on disease control rather than causes. Various more or less effective methods of treatment were put forward. Riedel in 1751 recommended *excision* for cankers of trees—still an accepted treatment and *bleeding* to remove superfluous sap, an analogy with the medical ideas of the times which hardly accords with our ideas.

(c) *The Ungerian Period* (1807-1853).

Pathology in this period became a recognised field for scientists. The separate philosophic and practical points of view of the preceding period were united by Unger, in 1833, in his "Exantheme der Pflanzen." In the early half of the Nineteenth Century the foundations of Botany as a science were laid. Pathology appealed to the botanical physiologists of the day, and, as a consequence, Unger founded the School of Autogenetists. He considered that disease had its origin in internal disorganisation of the nutritive processes. Fungi associated with disease he recognised as distinct organisms, but regarded them as originating in the affected plants, the idea of spontaneous generation of life being a fundamental conception of the time.

At the close of the Autogenetic Era phytopathologic thought was primarily physiologic, the study of plant diseases had become distinctly scientific, and the cause of diseases was held to be autogenetic.

PATHOGENETIC ERA.

(1853 to about 1915.)

This era marks the foundation of Phytopathology as we know it to-day. The brilliant mycologic work of the Tulasne brothers on rusts, smuts, mildew, etc., and of De Bary, the founder of modern Mycology, on smuts, rusts and potato blight, proving the causative parasitism of fungi in these diseases; the passing of the conception of spontaneous generation, swept away by that great scientist and demonstrator, Pasteur; and the mental freedom from the dogma of the fixity of forms given to the scientific world by Darwin; proved the inspiration of a brilliant and productive period in Phytopathology. This inspiration, thriving on the fruits of its own production, has continued so that its effects in increasing strength are felt to-day. In spite of ups and downs caused by apparently insoluble problems and their brilliant solution, Phytopathology is to-day a young and vigorous branch of applied science, and still far from reaching the crest of its maturity. In this Pathogenetic Era biologic science became truly scientific being based upon accurate observation and experiment. It developed a healthy spirit of independence of thought in its followers prepared to accept nothing finally unless the truth could be demonstrated. The armchair philosophies of classic scholars gave way to theories based on data obtained in field and laboratory.

The historic and disastrous outbreak of Potato Blight (*Phytophthora infestans*) in Europe in 1844-45, as is often the case with the great disasters of history, was productive of good. It brought Phytopathology into world prominence and inspired the interest of the most noted scientists of the

day. It emphasised the part which parasitism played in plant disease and brought home in unmistakable fashion the relation of plant disease to national and world prosperity, and even to the movements of people.

As an instance of the latter near home, the spread of farming inland from the little pioneer settlement around Pt. Jackson in New South Wales had its stimulus largely in the rust which prevented the growth of wheat for flour near the coast. As another illustration, who can estimate the part played in the development of U.S.A. by the Irish Immigration which followed the historic epidemics of Potato Blight in Ireland in 1844 and following years?

The Kuhnian Period. (1853—1883).

This period was powerfully influenced by three great scientists, De Bary the mycologist, Liebig the chemist, and Pasteur the bacteriologist. Whetzel named it after Kuhn, the father of Phytopathology, whose book, "Die Krankheiten der Kulturgewachse" was published in 1858. Kuhn was a farm manager, an experimenter, a student and a lecturer in agricultural science. It was undoubtedly owing to the twofold (practical and theoretical) nature of his training that his was the first phytopathological work in which fungi were recognised as pathogenes. He recognised that disease might be due to physiologic causes on the one hand and to parasites on the other, though attributing to the former the greater importance. In this period we find Berkeley, the father of British Mycology, making England's first contributions to Phytopathology which were, however, addressed rather to growers than to scientists.

At the close of the Kuhnian Period phytopathologic thought was essentially mycologic though the physiologic side had not been entirely overlooked. The classification of diseases was etiologic, and the autogenetic idea of the origin of diseases associated with fungi had largely given way to the pathogenetic viewpoint. Pasteur, De Bary, Kuhn and others had demonstrated beyond doubt that parasites could, and did, cause disease.

The Pre-Modern Period. (1883 to about 1915).

Phytopathology now became recognised as a definite branch of applied science. Great advances were made in control measures. The application of bacteriological technique to laboratory methods led to greater knowledge of parasitism and widened the range as well as the number of plant parasites. Millardet, in France, developed an accidental discovery and produced Bordeaux Mixture which is still one of the best and most widely used fungicides. Burill in U.S.A. in 1878-1884 and Wakker in Holland in 1883-1889 first demonstrated that among the bacteria were pathogenes of plants.

In 1885 Phytopathology received its first official recognition by the formation of a section of Mycology in the Botanical Division of the United States Department of Agriculture. Two years later the title was changed to Section of Vegetable Pathology, a more suitable name for an applied science based by no means entirely on Mycology. The lead given by the United States was followed all over the world as it came to be recognised that the provision of phytopathological services was an essential function

of government. It naturally followed that pathologists appointed by Governments have been attached to departments of agriculture, horticulture and forestry, or experiment stations. Also arising out of the realisation of the important part played by disease in plant life, it was realised that educational institutions giving courses in agricultural and related studies must include Phytopathology as an essential subject. In some countries and especially in U.S.A. and Canada it came to be ranked as a major subject, and the first Chair of Phytopathology was founded at Cornell University in 1907.

The first official recognition in the Empire dates from 1890 when D. McAlpine and Dr. N. A. Cobb were appointed Plant Pathologists to the Department of Agriculture in Victoria and New South Wales respectively.

During this period two schools of pathologic thought existed. One, the Predispositionists, were the successors of Kuhn. The greatest exponent of this school was Sorauer. His attitude was that, while admitting that parasites played a definite part in disease causation, parasitic diseases were more the result of environmental conditions which affected the plants, directly or indirectly predisposing them to the attacks of parasites. His work "Handbuch der Pflanzenkrankheiten," published in 1874-1886 laid great emphasis upon the diseases of non parasitic origin. In its present fourth (and revised) edition, it still forms the standard work on such diseases. Marshall Ward, the greatest English pathologist up to recent times, was also a predispositionist in outlook. His studies in parasitism are said to have laid the foundations of all later investigations into the nature of susceptibility and immunity in plants. The other school, the Pathogenetists, predominated the Pre-Modern Period and found many distinguished followers. Hartig, the founder of forest pathology, Frank, Kirchner, Klebahn and Brefeld in Germany, Rostrup in Denmark, Eriksson in Sweden, Woronin in Russia, Bos in Holland, Prilleux and Delacroix in France, McAlpine in Australia, Scribner, Galloway, Erwin-Smith, Burrill, L. R. Jones, Arthur and others in America were outstanding figures. The leadership in Phytopathology, which had had its origin in Germany, passed to North America. There the enthusiasm of a younger group of scientific investigators, free from the dogmas and prejudices of tradition, found wide scope in an almost virgin field. In this Pathogenic School, the mycologic outlook was predominant. Many of its workers were mycologists rather than pathologists. The textbooks of the period, with the exception of a few by predispositionists, such as Sorauer's Handbuch, dealt essentially with parasitic diseases, and little attention was paid to either the non-parasitic diseases or to the relation of environmental factors to infection by parasites. Great advances were made in the determination of causes of parasitic diseases and in the classification of the pathogenes. Improvement in disease control resulted from new or improved fungicides, notably lime-sulphur solutions and finely divided sulphur dusts. A new line of attack on disease brought Phytopathology into contact with Genetics. The breeding of disease resistant plants, the most promising method of fighting diseases, has and is giving excellent results. This flourishing line of work had its origin in the pioneer labours of W. A. Orton of U.S.A., and Farrer in Australia.

Writers on phytopathological subjects found means for publication in various botanical, agricultural and other scientific serials. In 1911, Phytopathology, the first journal dealing only with pathological subjects, com-

menced publication as the official organ of the American Phytopathological Society. This Society was founded in 1909 and was the first of its kind.

The Pre-Modern Period marks the passing of legislation in various countries to control infectious diseases within their areas and to prevent the introduction of new diseases from other countries. It is not the place here to discuss the value of governmental regulations in controlling disease. Undoubtedly they are essential though not ideal. Quarantine has obvious defects, and is unfortunately a tempting means of interfering with trade competition between States and countries. Undoubtedly its effectiveness is largely aided by natural barriers such as oceans and wide stretches of arid lands, such as separate the agricultural areas of Western Australia from the rest of the world.

An essential feature of the recognition of phytopathology in agriculture, etc., has been the development of means to educate growers in the knowledge of the most effective known methods of disease control. A high standard of farming or horticulture undoubtedly is more effective in controlling disease than governmental regulations.

Modern Era.

(About 1915 to present time.)

This era marks, in my opinion, the passing of the Pathogenetist and Predispositionist Schools. The modern attitude is wider and more scientific. Disease is recognised as being due to disturbances of

(a) Genetic origin. The results of undesirable mutations or of undesirable recombination of Mendelian factors. In this group may be classed self-sterility and hereditary dwarfings, chloroses, and malformations.

(b) Physiogenic origin. The result of undesirable reactions between plants and environmental factors. This constitutes the large group of diseases of non-parasitic origin.

(c) Parasitic origin. In these it is recognised that three groups of factors are concerned: the host, the parasite and the environment. For effective disease causation all three must be conjointly favourable. If all are at or near the optimum for disease causation, an epidemic or epiphytotic results. It is recognised that the environment acts not only on the parasite but also on the host, that it may aid the one and predispose the other. Thus it is that the school which regarded the predisposing effects of environment as the dominant factor in disease and that which looked upon the parasite as the outstandingly important factor, find their views merged into one.

The year 1915 has been tentatively chosen as marking the beginning of the Modern Era because in that year Edgerton experimentally demonstrated the relation of air temperatures to certain apple diseases. That parasitic diseases were related to certain environmental factors such as moisture and temperature, had been recognised as far back as the Ancient Era. Definite proof had been lacking, and, except in the Predispositionist School, little attention had been paid to this point except to record more or less casual observations. The classical work of the new viewpoint originated at Wisconsin University under L. R. Jones and his colleagues. Their attitude may be stated as "Explanation of the occurrence and severity of a parasitic

disease requires not only the recognition of the parasitic or 'casual factor,' but also the definition of the 'conditioning factors' of environment," and "the associated abnormal conditions which we term 'disease' are the resultants of the interaction of a plastic host and a plastic parasite under the play of variable environment" (6). This viewpoint appears to the writer to be the basis of the modern outlook on Pathology. It has involved not only a change in the outlook of the pathologist, but also in the training of future pathologists. It is obvious that mycology is not to be the dominating study of the future pathologist. Genetics, Bio-chemistry, Physiology and especially the physiology of parasitism, are equally essential. For the translation of knowledge of diseases into the practical application of control measures on farms and orchards, etc., some more or less detailed knowledge of agriculture, horticulture, forestry, etc., are required. Such an intellectual equipment in these rapidly expanding branches of science is becoming beyond the capacity of individuals. Specialised branches of Pathology and the use of team work on pathological problems has become inevitable. Already we have Physiologic Pathologists and Mycologic Pathologists. Team work has already been productive of excellent results and gives great promise for the future.

In the Modern Era we find Pathology passing through a remarkably vigorous and productive phase. Undoubtedly this is largely due to a recognition that increase in crop production may be obtained by three methods—

(1) Improvement of cultural methods.
(2) Breeding of plants more suitable for specific conditions.
(3) Reduction of losses from disease and insect pests.

The success of the first two depends largely upon the third—the effective control of losses due to disease, etc. Hence the present recognition of the importance of Phytopathology.

The outstanding features of the Modern Era appear to be as follows:—

1. The recognition of the intimate association of the host, parasite and environment in parsitic diseases, and consequently of the importance of Physiology as well as Mycology in Phytopathology. The classic work at Wisconsin, U.S.A. (6) on the part played by soil temperatures and humidity in the development of soil-borne diseases of plants did much to bring home to pathologists the need of studying environment in relation to parasitic diseases.

2. The revival of interest in Physiogenic diseases, particularly, as a result of the great development of long distance transport of vegetable products, in those diseases peculiar to fruit in store. Work on these diseases has brought into further prominence the essential importance of Physiology and Bio-chemistry in Phytopathology. An outstanding result of the interest in this class of disease was the foundation, in 1921, of the Low Temperature Research Station at Cambridge, England. This station, working under the Food Investigation Board of the Department of Scientific and Industrial Research, has already done excellent work particularly in regard to Brown Heart of Australian apples exported overseas, a disease which, in 1922, caused a loss of approximately £250,000. The demonstration of this disease as a respirational one readily prevented by control of the atmosphere of refrigerated holds is a brilliant illustration of the value of Physiogenic Pathology and also of team work (2).

The field of Physiogenic diseases is large and almost untouched from the experimental point of view. Of special importance to Australia are those affecting fruit shipments overseas, particularly Bitter Pit, Internal Breakdown, Scald and Soft Scald of apples. The two former, according to reports on the 1927 season, constitute the principal causes of wastage of Australian apples in Europe. Work on Bitter Pit, carried on under the writer's direction in this State during the present year, has demonstrated conclusively that Bitter Pit is a disease developed in apples in consequence of premature picking. A simple method of determining the maturity of apples has been devised which offers great promise as an aid to picking. The results of this investigation have not yet been published.

The work done at Rothamsted, England (1) and elsewhere, in regard to the essential presence in the soil in minute quantity, at least for some plants, of available boron, manganese and other elements not generally regarded as essential plant nutrients, has already proved valuable in Australia. Grey Speck, a disease of wheat and oats in Europe recently recognised in this State and South Australia, has been shown in the latter State to be due to a deficiency in the soil of available manganese (11).

3. The discovery of Biogenic Forms of Rust Fungi by Stakman and his associates at Minnesota, U.S.A., and in other groups by these and other workers. This discovery has revolutionised the work of breeding rust and other disease-resisting plants, and accounts at least in part for the limited results in this direction obtained by plant breeders in the past.

4. The recognition of plant breeding as the most effective method of disease control. The breeding of disease resistant plants started by Orton in America, and Farrer (12) in Australia, has produced excellent results and promises to give even greater results in the future. The production of cabbages resistant to Cabbage Yellows in America, of bunt resistant wheats like Florence, and of flag-smut resistant wheats like Nabawa, in Australia, are illustrations of the results to be obtained. The production of early maturing wheats in our State, thus reducing the disorders due to moisture deficiencies in districts with a short growing season, has extended and promises still more in the future to extend the limits of our wheat belt. This phase links Phytopathology very definitely with Genetics, and further emphasises the intimate relation of Phytopathology with agricultural development.

5. The recognition of the importance of Virus diseases. The cause of these diseases is still unknown, though the fact that the juice of tobacco plants with mosaic will convey the disease to other plants was shown by Ivanovski as early as 1892. Allard in 1914 demonstrated that the same disease may be transmitted by aphides. Since then Virus diseases have received intensive study. Indeed it is probable that more investigations have been made in recent years in this group of diseases than in any other. Virus diseases have been shown to occur in most, if not all, of our crop plants and in some crops such as potato, tomato and banana they may constitute in Australia the most important factors limiting production. As Virus diseases are normally conveyed from affected to healthy plants by insects, mainly sucking insects, this group of diseases has brought Pathology into close touch with Economic Entomology.

6. The introduction of copper dust fungicides for seed treatment, following Darnell-Smith's demonstration in New South Wales of the value of copper carbonate dust for seed treatment of wheat as a preventative of

bunt; the introduction, as fungicides, of organic mercuric compounds such as Uspulun, Semesan and many others; the adoption of dusts, mainly with copper sulphate, copper carbonate or sulphur as the active ingredients, as substitutes for liquid fungicides for use in crops, particularly fruit trees; these represent the most recent development in disease control with fungicides.

7. In 1921 the Imperial Bureau of Mycology, an institution supported by the governments of the British Empire, was founded. It serves to link together the pathologists of the Empire and, like its sister bureau, the Imperial Bureau of Entomology, has been markedly successful. In 1922 it commenced to issue the Review of Applied Mycology, the first purely phytopathological abstracting journal. This has become recognised as a model of its kind and is of greatest value to pathologists throughout the world.

Many other phases of recent development in Phytopathological work could be mentioned. The foregoing, however, appear to the writer to especially indicate the trend of phytopathologic thought and to mark the principal points of recent development.

PHYTOPATHOLOGY IN AUSTRALIA.

Before closing this address I propose to give a short outline of the development of Phytopathology in Australia. We appear to have passed through two stages and to be on the threshold of a third. In the first stage, belonging to the Pre-Modern Era, the phytopathological workers of Australia were men from abroad, without specific training in Pathology, but who by their keen interest and natural ability helped to develop the study and lay the foundations of modern Pathology. These were succeeded in quite recent years by students of the Modern Era trained in Australia. These men received a training in scientific agriculture, including Pathology, and in many cases had had more specific training in Pathology abroad, particularly in America. Phytopathological work being regarded as a State function and the staffs being limited, investigational work had not only been subordinated to a large extent to routine identification of diseases and the promulgation of known methods of control, but had also been carried out without any more than a casual and unofficial co-operation between the workers in different States.

With the appointment in 1927 of Dr. B. T. Dickson, a Canadian Phytopathologist, as Chief, Division of Economic Botany, under the Commonwealth Council for Scientific and Industrial Research, which was established in 1926, a new period appears to be commencing. In the development, by the Council for Scientific and Industrial Research, of central laboratories for fundamental research, the appointment of a staff of research workers free from routine and advisory duties, co-operation with State workers and the allocation and co-ordination of research throughout the Commonwealth, there lies great opportunity for a marked speeding up in Phytopathology. Already this latest development has stimulated co-operation between workers, has reduced overlapping investigations in a country where the workers are so few, and by direct aid to State investigations with money, equipment and men has given most promising results. There is at present a feeling of optimism and enthusiasm amongst pathologists due, in this State at least, to a recognition that the period of isolation so marked in the past is passing for all time. The absence of col-

leagues of similar interests with whom to consult, the defects of libraries and equipment, the ignorance of the work going on with other States, and the feeling of geographical and mental isolation are passing. To the Imperial Bureau of Mycology, which links the pathologists of the Empire and to the Council for Scientific and Industrial Research and particularly to Dr. Dickson, as its pathological adviser, we owe this change. We know that we can refer our difficulties in identification and in literary references to the Imperial Bureau with certainty of receiving all the assistance it is able to give. Our local problems and difficulties we can refer to the C.S.I.R., knowing that so far as the problems justify it will co-operate with the State in any way which promises results.

In May, 1890, Daniel McAlpine was appointed Plant Pathologist to the Department of Agriculture in Victoria. This was the first appointment of the kind in the Empire and was closely followed in August of the same year by the appointment of Dr. N. A. Cobb to a similar position in New South Wales.

McAlpine, the father of Phytopathology in Australia, became, with Marshall Ward of England, one of the two greatest workers in this field in the Empire. Born in Scotland in 1849 he came to Australia in 1884 as lecturer in biology in Ormond College Victoria. Appointed in 1890 as Plant Pathologist, he held that position until 1911 when he retired to take up a special investigation into Bitter Pit of apples under the Commonwealth Government. In 1915 he retired. Seventy four years of age and still taking an interest in the subject to which he contributed so much, the grand old man of Phytopathology in Australia rests on his laurels in retirement. Of his numerous publications, his monographs on the rusts and smuts of Australia are classics. These, with his monograph in five volumes on Bitter Pit, a systematic classification of the fungi of Australia, monographs on the diseases of potatoes and stone fruits, and many less important works, made him well known amongst phytopathological workers throughout the world. In Australia he became recognised as the greatest authority on pathological matters and to all intents and purposes he became unofficially the Plant Pathologist of Australia. He built up what is still the finest phytopathological library and herbarium in Australia. Essentially a pathogenetist, McAlpine belonged to pre-Modern times. Our outlook and technique have changed, our field has widened, our opportunities in education and equipment are greater, but still to the old man in Victoria we must render homage, not only as the pioneer in Australia but as one of the great world pioneers of modern pathology. May we never cease to accord recognition to the pioneers in all branches of Science who, like McAlpine, laid the foundations upon which we build to-day.

Cobb was more a predispositionist than McAlpine and interested himself in problems such as the resistance of wheat to rust rather than to those of purely mycologic interest. It was he who named that important export disease of apples, Bitter Pit. On the taxonomic side, Cobb, unlike McAlpine who described and named many species of fungi, was more interested in nematodes. This eventually became his chief interest and he is to-day Senior Nematologist to the U.S.A. Department of Agriculture Cobb resigned in 1905.

C. C. Brittlebank who had been McAlpine's assistant, succeeded him in 1911. Brittlebank came from England. His assistants are products of

the Melbourne University. Their appointment and the recent provision of up to-date laboratory equipment marks the beginning of the change over from the first to the second period in Australian Phytopathology.

Cobb in New South Wales was succeeded by Dr. Harvey Johnson, and the latter by Dr. Darnell Smith. In 1927, Dr. R. J. Noble, a graduate of Sydney University succeeded Dr. Darnell-Smith, again marking the change over to locally trained men.

The position of Melbourne as the centre of phytopathological work in Australia, a status which was gained in McAlpine's day, has gradually passed to Sydney. This has been largely a result of the courses in Pathology and Genetics in the Agricultural School of Sydney University under the stimulating and inspiring influence of W. L. Waterhouse. Waterhouse, a Sydney graduate, with agricultural experience and post graduate training in England and America, is turning out young pathologists who have already made a distinct impression on the work in Australia. Though the outstanding teacher in phytopathology in Australia, Waterhouse is essentially an investigator and is carrying on, under Australian conditions, the work of Stakman and his colleagues in America on rusts and smuts of cereals. He was appointed Lecturer in Plant Pathology at Sydney University in 1921, the first full time position of its kind in Australia.

At present every State has workers in pathology attached to Departments of Agriculture, or similar Government Departments except in South Australia, where the Pathologist is attached to the Waite Agricultural Research Institute.

The staffs at present are as under:—

New South Wales.—Biologist and six assistants in phytopathology.

Victoria. Biologist, Plant Pathologist and two assistants

Queensland. Three Pathologists (including two on diseases of sugar cane).

South Australia.—One Pathologist.

Western Australia. Economic Botanist and Plant Pathologist and one assistant in phytopathology.

Tasmania. One Microbiologist.

In nearly every case these workers are trained in Australia As must be obvious from the size of the staffs given above, except possibly in New South Wales, where the staff has increased considerably in recent years, research has had to be largely subordinated to routine work. Nevertheless, and particularly in recent years, our pathologists have helped to maintain the status of Australia earned by McAlpine and other early workers. It is difficult to single out the more important contributions, but the following appear to be particularly worthy of note:—

1. The introduction of copper carbonate dust for cereal seed treatment by Darnell-Smith (4).
2. Waterhouse's contributions to our knowledge of our rusts and smuts, their biogenic strains and the breeding of resistant varieties (13-14).
3. Nobles work on *Urocystis graminis* (8).
4. Hamblin's and Hyne's work on Helminthosporium spp. on wheat (5).

5. North's work on diseases of sugar cane (9).
6. Magee's determination of the cause of Bunchy Top of Bananas (7).
7. Pittman's work on Spotted Wilt of Tomatoes (10).
8. Samuel and Piper's work on Grey Speck of Oats in South Australia (11).
9. Carne's work on *Phytophthora hibernalis* (13).

The Commonwealth first came into the field of Phytopathology in 1911, when McAlpine was appointed for four years to investigate the cause and control of Bitter Pit in apples. Unfortunately this investigation was not very fruitful of results. In 1924 the Commonwealth Institute of Science and Industry, in co-operation with the Departments of Agriculture in New South Wales and Queensland, initiated investigations into the cause of Bunchy Top of Bananas. This disease, which was reported in Australia for the first time in 1913, is one of the most outstanding in the rapidity with which it practically wiped out an industry over a large area in New South Wales and Queensland. In the former State banana planting reached its maximum in 1922. By 1927, 90 per cent. of the area in the Tweed and Brunswick districts had gone out of production. The production in 1922 in Northern New South Wales was 460,000 cases. By 1925 this had fallen to 140,000. In the Currumbin district, in Queensland, the yield of 102,000 cases fell to 2,500 in 1925, and only five men were making a living where approximately 200 had previously found employment. Investigations by C. J. P. Magee, a Sydney graduate, demonstrated that Bunchy Top was a virus disease of the "potato leaf roll" type conveyed by the banana aphis (7).

In 1926 the Commonwealth Council for Scientific and Industrial Research co-operated with the Waite Institute in investigating the Spotted Wilt disease of Tomatoes, by far the most important disease of this crop in Australia. The Council provided funds for an insect-proof glass house, and also the services of a pathological assistant. The latter, H. A. Pittman, in 1927 demonstrated that Spotted Wilt is a virus disease and found that it was conveyed by the common leaf thrips (*Thrips tabaci*) from affected to healthy plants (10).

At present the Council is co-operating with the State workers in the investigation of diseases in several States, and in this State it has this year provided the services of an assistant in connection with the investigation of Bitter Pit out under my direction.

CONCLUSION.

In conclusion, it is evident that Pathology at the present time is receiving more attention and more support throughout the world than at any time in its history. There is little doubt that it will return many fold the interest, enthusiasm, and funds which have and will be given to it. Pathology in Australia is vigorous and healthy, and with the helpful stimulus now coming from both Commonwealth and State Governments, promises to be even more productive of good. Science knows no boundaries. Diseases ignore States. The healthy spirit pervading Phytopathology in Australia, as elsewhere throughout the world, insures greater economy of effort, a more rapid solution of problems, and ultimately an increase of agricultural production in Australia, provided that Commonwealth and States continue to work together on the present basis of helpful co-operation.

BIBLIOGRAPHY.

1. BRENCHLEY, W. A.—Inorganic Plant Poisons and Stimulants, 2nd Edn., pp. 134. Cambridge University Press, 1927.

2. ANON. Brown Heart in Aust. Apple Shipments, Dept. Sci. & Indust. Res. Food Invest. Spec. Rept. 22 : 1–28, London, 1925.

3. CARNE, W. M.—A Brown Rot of Citrus in Aust. Journ. Roy. Soc. W.A., xii : 13–41, 1925–6. Published 1927.

4. DARNELL-SMITH, G. P.—A Dry Method of treating Seed Wheat for Bunt. Agric. Gaz. N.S.W., xxx. 10 : 685–692. 1919.

5. HYNES, H. J.—Investigations of the late C. O. Hamblin into the Helminthosporium Disease of Wheat. Journ. Roy. Soc. N.S.W., lvii : 160–172. 1923.

6. JONES, L. R., JOHNSON, J., AND DICKSON, J. G.—Wisconsin Studies upon the Relation of Soil Temperature to Plant Disease. Wisconsin Agric. Expt. Stn. Res. Bull. 71 : 1–144. 1926.

7. MAGEE, C. J. P.—Investigations of the Bunchy Top Disease of the Banana. Comm. Aust. Council, Sci. and Indust. Res. Bull. 30 : 1–64. 1927.

8. NOBLE, R. J.—Studies on the Parasitism of Urocys*is tritici, the organism causing Flag Smut of Wheat. Jnl. Agric. Res. xxvii, 7 : 451–489. 1924.

9. NORTH, D. S.—Leaf Scald. Col. Sugar Refg. Co. Agric. Rept. (Technical), No. 8. 1926.

10. PITTMAN, H. A.—Spotted Wilt of Tomatoes. Jnl. Council Sci. and Indust. Res. 1 : 2 : 74–77. 1927.

11. SAMUEL, G., and PIPER, C. S.—Grey Speck (Manganese Deficiency) Disease of Oats. Jnl. Agric. S. Aust. 31 : 696–705 and 789–799. 1928.

12. SHELTON, J. P.—The Methods of the late W. J. Farrer. Ag. Gaz. N.S.W., xxxvi : 6 : 403–413. 1925.

13. WATERHOUSE, W. L.—Studies on the inheritance of resistance to leaf rust in crosses of barley. Jnl. Roy. Soc. N.S.W. 61 : 218–247. 1927.

14. WATERHOUSE, W. L.—Studies in the Physiology of Parasitism. Ann. of Bot. xxxv 140 : 557–564. 1921.

15. WHETZEL, H. H.—An Outline of the History of Phytopathology. W. B. Saunders. Co., Philadelphia, pp. 126. 1918.

JOURNAL
OF
THE ROYAL SOCIETY
OF
WESTERN AUSTRALIA.
Vol. XIV.

1. PRELIMINARY NOTE
ON
The Chemistry of Concrete Otto of Boronia megastigma (Nees)

BY
A. R. Penfold, F.A.C.I., F.C.S.
Acting Curator and Economic Chemist, Technological Museum, Sydney.

Communicated by L. W. Phillips, M.Sc.

(Read August 9, 1927. Published December 14, 1927.)

Although the Concrete Otto of Boronia megastigma is a well-known article of commerce, practically no information is available regarding its chemical composition. It was with this objective in view that the writer commenced its examination in 1924. Since that date a very interesting account of this rutaceous plant from West Australia, together with notes regarding the preparation of the Concrete and some constants on the green oil separated from the extractive, appeared in the "Australasian Journal of Pharmacy," 20th October, 1926, pages 932-934. It was based upon a paper entitled "Work on Perfumes and Essential Oils done in West Australia," by Mr. W. B. Garner, contributed to the Australasian Pharmaceutical Conference held in Perth, W.A., in August, 1926.

The quantity of the Concrete Otto available for experimental purposes was naturally very limited, and its examination could not have been attempted had it not been for the courteous assistance rendered by Messrs. Plaimar Limited, Perth, W.A., in furnishing five ounces of the Concrete at cost price. On account of the large percentage of Triacontane present even this quantity failed to suffice, especially as the cost of further supplies proved prohibitive to the Institution to which I am attached. Mr. R. B. Scammell, B.Sc., of Messrs. F. H. Faulding & Co., Limited, Sydney, kindly overcame the difficulty and rendered invaluable assistance by furnishing several ounces in 1926 free of cost. This very generous donation was greatly appreciated, and the opportunity is availed of to express thanks for the gift.

The examination is naturally somewhat incomplete, but in view of the commercial importance of this Boronia Concrete in perfumery, the time is considered opportune for the publication of whatever information is available to pave the way for a more extensive investigation on much larger quantities of material. If any of the West Australian manufacturers should feel disposed to make available a quantity for further investigation, I shall be very pleased to undertake its examination.

Experimental.

The Concrete Otto of Boronia megastigma.

The samples received were of a greenish colour and butter-like consistency, possessing the powerful and characteristic odour of the flowers of the plant. The colouring matter, of course, was due to chlorophyll. The constituents which have so far been indentified are Triacontane (a paraffin of melting point 64°), a glyceride of palmitic and stearic acids, Phytosterols, free palmitic, formic, and caprylic acids with small quantities of ethyl-alcohol and ethyl formate, and unidentified phenolic bodies. These constituents undoubtedly form an excellent fixative or carrier for the odoriferous components consisting of an unidentified alcohol and probably β-Ionone.

The various samples of Concrete Otto, as received, gave the following chemical and physical constants, as shown in Table :- -

Date.	Melting Point.	$d\frac{15°}{15}$	n D	Acid No.	Acid No. plus Ester No.	Ester No. after Acetylation.	Source.
3 11 1924 ...	35 36°	$\frac{15°}{15}$ 0·8989	1·4752 (38°)	27·5	106·7	139 5	Plaimar, Ltd. Perth, W.A.
26 10 1926 ...	40°	$\frac{40°}{15}$ 0·9091	1 4826 (40°)	24 2	95·9	136·5	do
10 2 1927 (1925 product)	40 41°	$\frac{40°}{15}$ 0·9189	1·4842 (39°)	22 8	109·3	149 0	F. H. Faulding & Co. Ltd., Sydney.
10·2/1927 (1926 product)	39 40°	$\frac{40°}{15}$ 0 9173	1 4852 (38°)	30 5	107·3	147·8	do.

The best method of examination was found to be as follows : - 40-grams of the Concrete Otto were dissolved in 200 c.c. absolute alcohol by warming on a steam bath and the solution allowed to stand during the week end for the precipitation of the paraffin. The solution was then cooled to 15°, and the paraffin pumped off on to Buchner filter funnel. Six grams crude paraffin were thus obtained. The alcohol was removed from the filtrate by distillation under reduced pressure, whilst any further small quantities of paraffin which separated were removed by filtration. The residue was dissolved in ether and treated with 8 % sodium hydroxide solution for the removal of free acids and phenolic bodies. The weight obtained was 4·5 grams. The ether was distilled off and the residue treated with alcoholic potash solution to decompose the esters and glycerides present. The small quantity of oil thus recovered was subjected to distillation at 2-3 mm.

Determination of Triacontane. The various samples of crude paraffin were purified by re-crystallisation from boiling acetone when a final melting point of 64° was attained. It was definitely identified as Triacontane by combustion and molecular weight determinations.

(a) 0·1148 gram gave on combustion 0·3590 gram CO_2 and 0·1546 gram H_2O.

C - 85·29 %

H — 15·00 %

$C_{30}H_{62}$ requires C - 85·30 %

H — 14·70 %

(b) 0·9664 gram in 20 c.c. acetone elevated the boiling point 0·25°. M Wt - 429. $C_{30}H_{62}$ requires 422.

Determination of Glyceride.—The liquors from the hot alcoholic potash saponification were decomposed with dilute sulphuric acid and the combined fatty acids so liberated were re-crystallised from alcohol. They melted at 55-57° and possessed a mean molecular weight of 279.

The quantity, 9 grams, was altogether too small for identification, but experience with mixed glycerides from other sources leads one to tentatively class the acids as a mixture of stearic and palmitic. Glycerine was detected in the liquors, after removal of the fatty acids by filtration and volatile acids by steam distillation, by evaporation to dryness and extraction of the residue with a mixture of alcohol and ether. The residue after removal of solvent was confirmed as Glycerol by all qualitative tests, especially the Acrolein reaction.

Determination of Combined Volatile Acids. The filtrate from the solid fatty acids yielded a small quantity of volatile acid on steam distillation. The ammonium salt gave the qualitative reactions for formic acid, whilst the silver salt prepared therefrom by its chemical department confirmed same. 0·1062 gram of silver salt on ignition gave 0·0792 gram silver equalling 74·57 %. (The slightly high result was due to contamination with reduced silver.)

Determination of Free Acids. The mixture of crude acid and phenols, being semi-solid, was placed on a porous tile for the absorption of the liquid phenol. The solid portion, on purification from methyl alcohol, melted at 62°. Combustion and molecular weight determinations offered confirmation of its identity with palmitic acid. A mixed melting point determination made with a sample of the acid from another source showed no depression.

Another sample of crude acid and phenol showed the presence of free formic and caprylic acids, the former being recognised by its qualitative reactions, and the latter by ignition of its silver salt: 0·0628 gram gave 0·0273 gram silver 43·47 %. The silver salt of caprylic acid requires 43·02 % Ag.

Determination of Phytosterols. The oily portion remaining after removal of chlorophyll, free acids, phenol, esters, etc., soon solidified to a solid of butter-like consistency resembling Eudesmol. It was treated with petroleum ether (B. Pt. below 60°) which permitted the separation of a white solid. This constituent on re-crystallisation was resolved into various fractions, melting at 170°, 166°, 150° and 142°. An average sample purified from alcohol melted at 162°. It was distinguished by the magnificent magenta colour given when a drop of sulphuric acid was added to its solution in chloroform and acetic anhydride. It was found to be optically active.

0·0723 gram in 10 c.c. chloroform gave a mean reading of −0·44°, $[\alpha]_D^{20°}$, −60°.

A molecular weight determination by the boiling point method gave the following result:

0·6088 gram in 23 c.c. acetone elevated the boiling point 0·15°.
M.Wt. 395. $C_{27}H_{46}O$ requires 390.

The combustion results, although not quite so good, yet pointed to a molecular formula of $C_{27}H_{46}O$. The acetate was prepared, but it melted indefinitely between 120-130°, the quantity being too small for rigorous purification.

Determination of Essential Oil. The portion of essential oil obtained from 40 grams of the Concrete Otto measured 8 c.c., and on distillation at 2-3 mm. behaved as follows:-

1st drops 80° collected 80-120° 1 c.c.
and 120-140° 6 c.c.

The latter had $d_{15}^{15°}$, 0·8743; $\alpha_D^{30°}$; $n_D^{20°}$, 1·4716.

On further distillation a fraction of 3 c.c. was obtained, boiling at 125-129° at 3 mm. and possessing

$d_{15}^{15°}$ 0·8845, a_D −1·2°, $n_D^{20°}$ 1·4738.

A second preparation yielded 4 c.c., distilling at 130-150° at 10 mm., having

$d_{15}^{15°}$ 0·8807, a_D −6°, $n_D^{20°}$, 1·4726.

A third preparation gave the following results :—

	Volume.	d 15°/15	a D	n 20° D
130-133° 4–5 mm.	2 c.c.	0·8763	2·2°	1·4695
133-153° 4–5 mm.	2 c.c.	0·8618	−2·0°	1·4650

None of the fractions referred to reacted with phenylisocyanate, napthylisocyanate or phthalic anhydride. They appeared to be mixtures of high boiling alcohols with ketones. The molecular weights of the various fractions varied from 189 to 200. The combustion results were of little value but they pointed to the presence of an alcohol of 12 carbon atoms, and no evidence could be obtained with the small quantities available as to whether the principal fractions represented a chemical entity.

When the Concrete Otto, as received, was treated with aqueous potash solution as in the isolation of low boiling alcohols, free and combined, it was found that the volatile oil which came over differed somewhat from that obtained during treatment with alcoholic potash solution, as will be observed from the following results :

Lot 26/10/26 22 grams crude Otto yielded 2½ c.c. of oil.
$d_{15}^{15°}$ 0·9071, a_D −8·8°, $n_D^{20°}$ 1·4840

Lot 10/2/27 20 grams crude Otto yielded 1½ c.c. of oil.
$d_{15}^{15°}$ 0·8861, a_D 1·6°, n_D 1·4804

Determination of β-Ionone. The highest boiling fractions of the volatile oils possessed a pronounced but characteristic odour of β-Ionone, and these on treatment with semicarbazide hydrochloride and sodium acetate solutions yielded a crystalline derivative. This resembled in general physical characters the semicarbazone of β-Ionone, and moreover melted at 145–146°. The semicarbazone of a commercial sample of β-Ionone was prepared, and this on purification from ethyl alcohol melted at 148-149°.

A mixed melting point determination made with a mixture of the two specimens showed no depression. The presence of this ketone requires confirmation as I have been unable to trace any record of its previous occurrence in nature.

Determination of Ethyl Alcohol.- Apart from a small quantity of ethyl alcohol occurring as formate, about 5% of this alcohol was separated from the Concrete Otto by washing with warm water. It was identified by the Iodoform reaction and oxidation to acetic acid by means of potassium permanganate solution.

0·2130 gram of silver salt gave 0·1373 gram silver 64·46% Ag.

The silver salt of acetic acid requires 64·67% Ag.

Since the manufacturers have assured me that this alcohol is not used in the preparation of the Concrete Otto, it must, therefore, be naturally, occurring.

In conclusion, my thanks are due to Mr. F. R. Morrison, F.C.S., A.A.C.I. Assistant Economic Chemist, for much assistance in this investigation.

By Authority: Fred. Wm. Simpson, Government Printer, Perth.

2. CONTRIBUTIONS TO OUR KNOWLEDGE OF WEST AUSTRALIAN POISON PLANTS,

Series i.,

BY

H. W. Bennetts, B.V.Sc.,
Veterinary Pathologist, Department of Agriculture, W.A.

(*Read 9th August*, 1927. *Published 14th December*, 1927.)

It is proposed in this first contribution to indicate briefly details and results of some of the feeding tests carried out with W.A. poison plants, during the period from 1925 up to the present date.

1. Purpose of Experiments.

(1) To obtain knowledge of toxicity of plants under review at different stages of growth, this, in some instances, in response to applications from members of the public.

(2) To obtain knowledge as to type of symptoms and pathological changes induced by various species of plants, thereby filling up gaps in our present knowledge as well as giving indications for chemical investigations should such be undertaken.

(3) To test the action of antidotes, recommended, on the toxic properties of plants representative of the genera *Gastrolobium* and *Oxylobium*. These two genera contain the bulk of the Western Australian poison plants.

2. Technique.

(1) *Plant Material.* Material, obtained in as fresh a state as possible, has often been received from stock owners, and at other times collected in response to request. As many different stages of growth as were obtainable have been tested, viz., seedlings, suckers, adult non flowering and flowering and fruiting plants. Identifications have been made in each case by the Economic Botanist of the Department of Agriculture.

(2) *Dose and Method of Administration.* The majority of the plants under review are said to be very highly toxic, as evidenced by experience in the field, acute symptons being produced with small quantities. The harsh nature of the plants is usually such that only small quantities would be likely to be eaten by stock except perhaps in the flowering stage. Hence the doses administered to experimental animals have usually been relatively small. The size of dose has also been influenced by the fact that supplies of plants have in most instances not been accessible close to Perth and it has not been considered advisable to test plants except when quite fresh. This has meant that duration of feeding tests has not exceeded more than a few days. The mode of administration has almost invariably been voluntary ingestion. Sometimes starving of experimental subjects had to be resorted to before feeds containing plants to be tested would be eaten. The idea of drenching plant preparations is not favoured.

(3) *Experimental Animals.* -In the absence of facilities for the housing and handling of larger animals, guinea pigs and wild rabbits have been mainly used as experimental subjects. The rabbit would appear to be more satisfactory for differentiation of symptoms than the guinea pig, though both are very susceptible to the action of poison plants.

It may be a fallacy to draw conclusions from the results of feeding tests on laboratory animals and apply them to stock generally, but in most instances the information obtained by laboratory tests appeared to correspond with field observations of the effects of the plants in question.

(4) *Working Methods.*—The same methods have been followed throughout the course of these experiments, so that it will save repetition if these are given at this stage.

In the cases where the plants appeared palatable they were fed alone without prior preparation, but as in most instances the plants tested were of hard fibrous nature, portions of the plant used were fed in finely divided condition, either minced or chopped, or, as in the case of seeds, pulverised in a mortar.

A weighed quantity of the prepared plant was well mixed with a known quantity (usually 10-15 grams) of bran or chaff and moistened with water. The feed was weighed both dry and wet, and fed. The residue not eaten by the animal was weighed wet and the weight of the plant eaten was calculated.

Feeds were, as a rule, administered twice daily, morning and evening.

Symptoms were noted where possible and post mortem examinations were conducted, obviously pathological tissues being subjected to microscopic examination.

3. Present Knowledge.

An excellent symposium on our present knowledge is contained in a monograph :—" The Poison Plants of Western Australia " (Revised Edition 1926, Bull. No. 96. Dept. of Agriculture, W.A.). This publication has proved a valuable guide to the present investigations.

Section A. Toxicity Experiments Positive.

Oxylobium parviflorum, Benth. " Box Poison."

History. This is one of the best known native poison plants and has a very bad reputation. It is considered to be most dangerous when flowering or fruiting. It is also toxic in the seedling stage. A toxic alkaloid " lobine " was isolated by Mann and Ince from this plant.

Experiment No. 1 :

(1) Source specimens—Economic Botanist.

(2) Nature specimens—Seeds.

(3) Date collected—December, 1924 ; Tested 2-2-26.

(4) *Details*—Guinea pig No. 1 showed symptoms 18 hours after eating 0·1 grams seed, and was found dead 24 hours later. Guinea pig No. 2 was found dead 18 hours after being fed, 0·07 grams being eaten.

(5) *Symptoms.*—Dullness, loss of control of hind limbs, later clonic spasms were apparent, followed by coma.

(6) *Post mortem.*—In both cases congestion—microscopically well marked congestion of liver, kidneys, and lungs.

Experiment No. 2 :

(1) Locality specimens—East Beverley.

(2) Nature specimens—Old plant, dying off.

(3) Date received—14-4-26 ; Tested 14-4-26.

(4) *Details.* A sheep was given four ounces per day for six days, most of which was eaten, and showed symptoms on seventh day. The animal was dull and on " shaking up " exhibited inco-ordination of gait. For next few days the sheep would eat no feed containing box leaves and during this period gait was described by attendant as being " stiff." The sheep recovered on the third day.

Experiment No. 3:

(1) Source specimens—Economic Botanist.

(2) Nature specimens—Seeds.

(3) Date collected—December, 1924; Tested 1-2-27.

(4) *Details.*—Five rabbits and nine guinea pigs succumbed to the effects of eating seeds in the course of experiments, the details of which are given later.

(5) *Symptoms.*—In the case of rabbits there was always conclusive evidence of convulsions prior to death, though none were actually seen at this stage.

Guinea pigs showed symptoms as described for Experiment No. 1. They do not, apparently, become affected with convulsions to the same extent as rabbits.

(6) *Post mortem*—Lesions as described for Experiment No. 1.

General Conclusions.—Seeds of *O. parviflorum* are very highly and constantly toxic for laboratory animals, rabbits being affected with convulsions prior to death.

Oxylobium tetragonophyllum, E. Priztel.

History.—A suspected plant not previously known to be toxic.

Experiment:

(1) Locality specimens—Ravensthorpe.

(2) Nature specimens—Fresh flowering plant.

(3) Received 27-8-26; Tested 30-8-26 and 6-9-26.

(4) *Details.*—During my temporary absence feeding experiments were carried out with this plant by J. Filmer, Veterinary Officer, Fremantle, and he has kindly made his results available for publication. On 30-8-26 a guinea pig and a rabbit were fed with mixed flowers, leaves and buds. Both animals succumbed, 3·4 grams of plant having been eaten by the guinea pig and 3·5 grams by the rabbit. On 6-9-26 another rabbit was fed with flowers and buds (which had previously been soaked for 5 hours in a 1% aqueous solution of potassium permanganate) with fatal result, the animal having eaten 4·0 grams of plant.

(5) *Symptoms.*—Hypersensitiveness to external stimuli, and convulsions followed by death.

(6) *Post mortem.*—Congestion, particularly of liver, and in one case (guinea pig) kidneys showed small haemorrhages in the cortex.

(7) *Conclusions.*—"The flowers and buds of *O. tetragonophyllum* are very toxic. They are apparently only slightly irritant but have a pronounced nervous stimulant effect." The toxic effect was still apparently undiminished nine days after plant received. "This plant when in the flowering stage is likely to prove toxic for some time after grubbing."

Gompholobium marginatum, R. Br.

History.—A suspected poison plant—no confirmatory evidence available.

Experiment:

(1) Locality specimens—Coolup.

(2) Nature specimens—Fresh fruiting plants.

(3) Date received—29-9-25; Tested 29-9-25.

(4) *Details.*—Guinea pigs were fed solely on the plant. Guinea pig No. 1 ate 50 grams and was found dead 42 hours after first feed. Guinea pig No. 2 ate 130 grams in 65 hours and appeared dull but recovered. A wild rat was daily given small amounts, and was found dead five days after first feed.

(5) *Post mortem.*—Congestion; microscopically, kidneys, liver, and lungs showed congestion and haemorrhage.

(6) *Conclusion.*—*Gompholobium marginatum* appears to be toxic for small animals, in fruiting stage, when relatively large amounts are eaten. Further experiments are indicated.

Gastrolobium bidens, Meissn. "Kite Leaf Poison."

History.—This plant is known to be toxic in flowering and fruiting stages. Symptoms and post mortem appearance unknown. Correspondent providing specimens states the plant to be highly toxic for sheep in the seedling and sucker stages.

Experiment No. 1:

(1) Locality specimens.—Latham.

(2) Nature specimens.—(a) Seedlings; (b) Suckers; (c) Adult plants bearing fruit pods not yet fully grown. All samples appeared quite fresh on arrival.

(3) Date collected—25-9-26; received—28-9-26.

(4) *Details*:—

Experimental Animal.	Feed.	Date.	Amount.	Plant Eaten.	Result.
			days.	Total.	
Sheep No. 1 ...	Whole Seedlings and Chaff	28-9-26 29-9-26	19 37	56	Negative.
Sheep No. 2 ...	Whole Suckers and Chaff	28-9-26 29-9-26 30-9-26	20 40 40	100	Negative.
Sheepo No. 4 ...	Fruiting Plant and Chaff	28-9-26 29-9-26 30-9-26 1-10-26	... 115 80 25	220	Negative.
Rabbit No. 4 ...	Seedlings only	28-9-26 29-9-26	5 10	15	Negative.
Rabbit No. 5 ...	Suckers only ...	28-9-26 28-9-26 30-9-26	9 9 6·5	24·5	Negative.
Rabbit No. 6 ...	Leaves and Pods	28-9-26	6·5	6·5	Dead 29-9-26.
Rabbit No. 10 ...	Pods and Bran	4-10-26	0·6	0·6	Dead 5-10-26.

Note. The weights are expressed in grams. The housing arrangements for the sheep were very primitive. The sheep were confined in a small space without the possibility of exercise (said to make manifest toxic action of Gastrolobiums and Oxylobiums in general) throughout the feeding experiment.

(5) *Symptoms.*—No symptoms were seen, though the attitudes in which rabbits 5, 6, and 10 were found after death, and appearance of cages were unmistakable evidence that the animals had been affected with violent convulsions prior to death.

(6) *Post Mortem appearances.* Injection of subcutaneous vessels and of mesentery and intestines.

Liver—Marked congestion, and microscopically congestion, hæmorrhage, cloudy swelling, and early fatty changes.

Kidneys—Congestion of cortex and medulla, confirmed by microscopic examination, which also revealed hæmorrhages.

Lungs—Bright red in colour.

(7) *Conclusions*

1. The toxicity of freshly obtained seedlings, suckers and early fruiting plants of *G. bidens* for sheep and rabbits has been tested.

2. Though feed was eaten fairly readily negative results have been obtained with the exception of rabbits receiving fruit pods.

3. The results obtained would appear to indicate that either (a) The plant is not so highly toxic as reported; or (b) The toxic properties are lost very soon after picking; or (c) In sheep, exercise is an important factor in production of fatal results following the ingestion of *G. bidens.*

4. The fruiting plant is much more highly toxic than seedling or sucker stages.

Experiment No. 2:

(1) Locality specimens—Latham.

(2) Nature specimens—Fresh green plants bearing fully grown unripe fruit.

(3) Date—Collected 13 10 26; received 16 10 26.

(4) *Details.* Two rabbits used as controls in an experiment detailed later, succumbed to the effects of eating fruit pods. Rabbit 13 ate two grams of fruit pods on 18 10 26 and died the following day. Rabbit 21 ate three grams of fruit pods on 21 10 26 and was found dead on 22 10 26.

(5) *Symptoms.* Rabbit 13 at 8·45 a.m. was found to be dull and refused to move. Two minutes later animal was affected with violent convulsions which lasted for a short period and were followed by decubitis, air hunger, and death all within ten minutes of first observing it.

Post mortem as in Experiment No. 1.

(6) *Conclusions*

1. The ingestion of less than five grams of fruit pods by rabbits is followed by death.

2. Symptoms as also indicated in Experiment No. 1, shown by rabbits, result from great nervous stimulation.

Gastrolobium bilobum, R. Br. "Heart Leaf Poison."

History. "Toxicity is greatest during flowering and seedling stages and after rains"

Symptoms said to be drowsiness, motor paralysis, etc., different from those produced by most other Gastrolobiums.

Experiment No. 1:

(1) Locality specimens—Albany.

(2) Nature specimens—Fresh portions of green plant bearing ripe seeds.

(3) Date collected 26 1 26; received 28 1 26.

(4) *Details.* Guinea pig No. 1 was found dead on 29 1 26, having eaten 0·08 grams of seeds fed on 28 1 26. Guinea pig No. 2 ate 7·25 grams of leaves in two days without showing any symptoms. Animal subsequently showed symptoms after eating 0·1 grams of seeds, and then ate very small amounts of feeds containing seeds, consuming only 0·04 grams of seeds in two days. Symptoms gradually diminished, guinea pig apparently

Experiment :

(1) Source specimens.- L. W. Phillips, M.Sc.

(2) Nature specimens.—(a) Dry flowers and buds : (b) Dry shoots from flowering plant.

(3) Date. Received 21 10 26 ; tested 21 10 26.

(4) *Results.*—Rabbit No. 1 was found dead 22 hours after being fed with (a), having eaten 1·0 gram of flowers. Rabbit No. 2 died approximately 24 hours after being fed with (b). 1·5 grams of shoots having been eaten.

(5) *Symptoms.*- Rabbit No. 1 apparently was affected with violent convulsions prior to death. Twenty-two hours after being fed Rabbit No. 2 was noticed to be dull. External stimuli elicited an attack of convulsions lasting for a short time, after which the animal appeared moribund, heart action almost imperceptible. Shortly afterwards condition was much improved though animal showed signs of nervous excitement. Half an hour afterwards the rabbit died after a similar convulsive attack.

(6) *Post mortem.* Congestion particularly of liver and kidneys.

(7) *Conclusions*

1. Dried flowers, buds and shoots of *G. calycinum* are toxic for rabbits in small quantities.

2. The effects produced appear to be due to profound nervous stimulation.

Gastrolobium crassifolum, Benth. "Narrow Leaf Poison."

History.—Said to be "dangerous at all seasons, but more especially so when flowering or seeding, or when producing young shoots after a fire."

(1) Locality specimens.—Northam.

(2) Nature specimens.—Flowering plant, leaves appear old and somewhat dried ; no flowers included in samples for testing.

(3) Date.—Received ? ; tested 16 5 27.

(4) *Details.*—A guinea pig ate 15 grams of plant within 41 hours without showing symptoms but was found dead on third day.

(5) *Post mortem.*—Liver congested and fatty. Kidneys showed parenchymatous nephritis.

(6) *Conclusion.* Fifteen grams of leaves of *G. crassifolium*, when plant was in flowering stage, were found to be toxic for a guinea pig

Gastrolobium densifolium, Gardner.

History.—New species, suspected of being toxic for stock.

Experiment :

(1) Locality specimens. Dudinin.

(2) Nature specimens. Fresh flowering plant.

(3) Date. Received and tested 23 10 26.

(4) *Details.*—Guinea pig No. 1 ate 12 grams minced plant, including flowers, in four days ; showing symptoms on fourth day when the experiment was discontinued because of lack of further material. The animal had recovered on the sixth day. Guinea pig No. 2 ate 7·0 grams of minced plant in three days and was found dead on fourth day.

(5) *Symptoms.* Anorexia, erratic movements, intermittent attacks of muscular tremors and dullness.

(6) *Post mortem.*—(G.P. No. 2) Congestion notably of liver and kidneys and lungs ; microscopically congestion and hæmorrhage.

(7) *Conclusion.*—The results obtained would confirm field evidence of toxicity, flowering plant being toxic for guinea pigs.

normal on the eighth day after commencement of feeding test. Guinea pig No. 3 showed symptoms after eating 0·22 grams seed pods and was killed 10 hours after symptoms first noticed.

(5) *Symptoms*—Guinea-pigs 2 and 3 showed a similar semi-comatose condition with intermittent muscular tremors and difficulty in moving. Guinea pig No. 2 would persist in pushing its head up into a corner of the cage and if moved would eventually return to this position.

(6) *Post mortem* -Macroscopically and microscopically no marked pathological changes. The congestion of the liver and kidneys so typical of poisoning with other gastrolobiums was entirely absent.

Experiment No. 2 :

(1) Locality specimens—Same as Experiment No. 1.

(2) Nature specimens -Seeds only used.

(3) Date—Same as Experiment No. 1.

(4) *Details.*—The animals referred to were used as controls of toxicity in an experiment on 9-3 27 detailed later. Guinea pigs Nos. 1, 2, and 4 showed symptoms within 18 hours of eating respectively 0·14, 0·07, 0·05 grams of seeds. Nos. 1 and 2 succumbed ; No. 4 recovered.

(5) *Symptoms.* -Dullness, erratic movements, followed by coma, and in Nos. 1 and 2 obvious loss of control of muscles particularly of hind limbs.

General Conclusions -

1. Heart-leaf seeds, even when over 12 months old, are highly toxic for guinea pigs.

2. Symptoms are characteristically those of depression and motor paralysis, as recorded, in contradistinction to usual Gastrolobium convulsive syndrome.

3. Post mortem lesions are very indefinite in contradistinction to the definite congestive changes which are a feature of the action of most Gastrolobiums.

Gastrolobium callistachys, Meissn. "Rock Poison."

History.—This plant is known to be toxic ; but here our information ends.

Experiment .

(1) Source specimens—L. W. Phillips, M.Sc.

(2) Nature specimens—Jar containing green leaves commencing to dry, labelled " Reputed highly toxic. No alkaloid present."

(3) Date—Labelled 23-6-27 ; tested 4-7-27.

(4) *Details.*—The total sample of 5·5 grams was fed to a guinea pig. Symptoms were apparent less than five hours after feeding, 1·3 grams having been eaten up till that time, when feed was removed.

(5) *Symptoms.*—Dullness, tonic muscular spasms.

(6) *Post mortem.*—Subcutaneous vessels injected, kidneys congested.

(7) *Conclusion.*—The leaves of *G. callistachys* would appear to be very highly toxic even some days after picking. This is contrary to the usual results obtained with W.A. poison plants.

Gastrolobium calycinum, Benth. "York-Road Poison."

History.—This is one of the best known and most dangerous of the W.A. poison plants. It is most toxic in the flowering and fruiting stages. Mann and Ince isolated an alkaloid " Cygnine " from this species.

Gastrolobium oxylobioides, Benth. "Champion Bay Poison."

History. "The period of maximum virulence are the seedling, flower, and fruiting stages. Affected animals die in convulsions."

(1) Source specimens.—Obtained from Economic Botanist.

(2) Nature specimens.—Seeds.

(3) Date. Collected (a) December, 1924 and (b) 5 1-17; tested (a) 2 2-26, and (b) 22 2 26.

(4) *Details.* A guinea pig ate 0·05 grams seeds (a) in 18 hours with fatal results. A rabbit ate approximately 1·0 grams of seed (b) in three days without showing symptoms.

(5) *Post mortem.*—(Guinea pig). General congestion. Microscopically liver showed congestion and cloudy swelling, kidneys acute parenchymatous nephritis, lung congestion.

(6) *Conclusion.*—Seeds of this plant would appear to be highly toxic even about 12 months after collection, whereas seeds 10 years old would appear to have largely if not entirely lost their toxicity.

Section B. Toxicity Experiments Negative Results.

In very many instances negative results have been obtained in feeding tests with plants known to be poisonous. In most instances the stage of growth submitted has probably been responsible for the negative results obtained. Usually requests for further specimens in the flowering or fruiting stages, the stages most likely to give positive results, have met with a negative response from stock owners.

Euphorbia eremophila (fruiting stage), *E. drummondii* (fruiting stage), *Gastrolobium brownii* (flowering stage), *G. microcarpum* (flowering stage), *G. parvifolium* (leaves), *G. velutinum* (flowering stage) and many other species, some of which were unidentifiable specifically, have been tested with negative results.

Gastrolobium villosum, Benth. "Crinkly Leaf Poison."

History. Known to be very toxic when flowering and fruiting.

At the request of a stock-owner I undertook experiments to determine whether seedlings, and adult non-flowering non-seeding plants were likely to be dangerous to stock.

Experiment:

(1) Locality specimens. Mooliabeenee.

(2) Nature specimens.—Fresh adult green plants and seedlings.

(3) Date. Received adult plant, 24–1–27; seedlings, 7–2–27. Tested adult plant 24–1–27; seedlings 7–2–27.

(4) *Result.* Two rabbits each ate 20 grams of *G. villosum* leaves within 40 hours; three rabbits ate respectively 51, 87 and 100 grams of seedlings in three days, for first one and seven days for last two. In no case was any detrimental effect noticed.

Note.—Other tests have been done at different times with green leaves from grown plants always with negative results.

(5) *Conclusions.*—Neither leaves of non-flowering, non-fruiting plants nor seedlings of *G. villosum* have been found to be toxic for laboratory animals. It would appear, and field evidence supports this, that *G. villosum* is probably only poisonous for stock when flowering or fruiting, unless, possibly, when eaten in large quantities at other periods.

Isotropis striata and Isotropis juncea. "Lamb Poisons."

History.—"Lamb Poisons are said to be dangerous to lambs, and to some extent to sheep also, but apparently not to other stock." There is no positive evidence of their toxicity except that lamb mortalities sometime

synchronise with the appearances of these plants and particularly the flowering plants. (The lamb mortality also synchronises with the period of the year when deaths may be expected from the Braxy-like Disease.)

Experiments :

Several feeding experiments with *I. striata* in the flowering stage (1925 and 1926), in which the plant formed the sole diet of guinea pigs and rabbits for some days, have all been attended with negative results, the plants being eaten with avidity. Filmer has also tested the plant with negative results.

One feeding test was done with *I. juncea*, also with negative results.

Conclusion. *Isotropis striata* does not appear to be toxic for laboratory animals.

General Conclusions from Feeding Tests with Plants of the Genera Gastrolobium and Oxylobium.

1. The results obtained from feeding tests, with laboratory animals, with plants of the genera *Gastrolobium* and *Oxylobium* would tend to substantiate statements (mainly founded on field evidence) already made, viz. –

(1) The toxic properties of the plants vary considerably with the stages of growth. The flowering or fruiting plant is the most dangerous, the flowers and fruit themselves being the most toxic parts of the plant.

(2) *Symptoms.* The separation of the plants contained in the genera into two groups, Group No. 1 containing the great majority of the plants in which the symptoms induced are those of nervous stimulation (York road, Box, etc.) and Group 2 in which nervous depression is the outstanding feature, (Heart leaf) would appear to have foundation. This differentiation would also appear to be borne out by the different pathological changes induced, congestion particularly of liver and kidney being characteristic of first group. In cases of poisoning by plants of the second group the pathological changes are indefinite.

2. Seeds of species tested have been found to be highly and constantly toxic for laboratory animals and apparently retain their toxicity for a considerable period, certainly in some cases for more than twelve months.

3. In view of this fact it would appear that the seeds are the most favourable in fact the only suitable part of the plant for chemical investigation.

4. Leaves of the plant, apart from seedlings which have seldom been available for test, have only very infrequently been found to be highly, if at all, toxic for laboratory animals (*G. callistachys* is a notable exception). It would appear that large quantities of leaves, except during flowering or fruiting periods, must be ingested before any toxic effect is manifested (symptoms were produced in a sheep after relatively large quantities of Box leaves were eaten) ; or that possibly toxic principles occurring in the leaves are unstable and disappear very soon after picking.

5. The great similarity in symptoms and post mortem appearances shown by laboratory animals, as a result of ingestion of species of Gastrolobiums and Oxylobiums tested, would indicate a similarity of type or identity of the toxic principles contained in the majority. The one probable exception is *G. bilobum*.

6. Two species, namely *Gastrolobium densifolium* (a plant not previously known) and *Oxylobium tetragonophyllum*, not prior to these experiments, classified as a " poison plant " have been found to be toxic for laboratory animals. In both cases the result substantiates field evidence of their toxicity.

Section C.—Experiments to Determine Action of Antidotes, recommended, on Toxic Properties of W.A. Poison Plants.

1. Origin of Experiments :

Potassium permanganate and "Poison Plant Antidote Tablets" (Mann's formula) were originally recommended by E. A. Mann as antidotes for poisoning with *Gastrolobium calycinum*, though considered to be probably effective for cases of poisoning with other Gastrolobiums and Oxylobiums.

Doubt has been expressed from time to time as to the efficiency of these antidotes, notably recently by a correspondent from Latham, who furnished me with samples of *G. bidens*, the subject of remarks in the first section of this paper (*vide* Section A of this paper). Hence experiments were initiated with this plant, with the object of testing action of antidotes on the toxic principles contained in it.

2. Technique :

In the first experiments four groups of animals were used. *Group No.* 1 consisted of the test group, the animals receiving a toxic dose of, usually, fruits soaked for about four hours in a 1% potassium permanganate solution - the solution being then filtered off through linen cloth and the residue well washed with tap water before being fed. *Group No.* 2 consisted of controls for water solubility of toxic principles, the animals of this group receiving feed as in first group treated with tap water instead of potassium permanganate solution. *Group No.* 3 was used as a control of toxicity, these animals receiving identical doses of plant not submitted to any treatment (except division) prior to feeding. A *fourth Group* was used to control possibility of potassium permanganate being retained in sufficient amounts to be toxic. Grass soaked for four hours in 1% potassium permanganate aqueous solution, and washed, was fed to these animals.

The first three groups received the plant well mixed with 15 grams of bran and water, as in toxicity experiments. All animals were fed at the same time and were, of course, kept in different cages. The animals of a given experiment were selected so as to be of fairly even weight.

In the experiments with *G. bidens* it was found that the only animals dying were those in Group 3, *i.e.* those receiving untreated plant. The conclusion then arrived at was that either the toxic principles were destroyed by, or were soluble in tap water. Lengthy experiments were undertaken to prove this but results obtained were somewhat irregular and owing to supply of rabbits giving out experiments with this plant were discontinued.

Definite results were, however, obtained with *O. parviflorum*, *G. bilobum* and *G. calycinum*, the technique being modified in the later experiments. Here as detailed the fluids in which portions of the plant were treated were fed with the plants.

3. Experiments with O. parviflorum.—"Box Poison."

For details of source of plant specimens, etc. [*vide* Section A, *O. parviflorum* Exp. No. 3.]

Experiment No. 1 :

(1) *Purpose.*—To determine action of potassium permanganate on toxic properties of seeds.

(2) *Details* -

(a) *Test Animal.*—Rabbit 30 received crushed seeds 0·5 grams soaked for four hours in excess of 1% aqueous potassium permanganate solution ; residue only, after filtering and washing, was fed.

(b) *Control Water Action.*- Rabbit 31 received crushed seeds 0·5 grams as in (a), except that tap water was used instead of potassium permanganate 1% solution.

(c) *Control Toxicity.*- Rabbit 32 received crushed seeds 0·5 grams untreated (except pulverised).

(d) *Control Potassium Permanganate.* Rabbit 33 received 10 grams grass soaked for four hours in 1% potassium permanganate solution and then washed.

The experiment was started on 1 2 27.

(3) *Results*—

On 2/2/27 Rabbit No. 32 (Control Toxicity) was found dead having, eaten approximately half of the seed (feed had been spilt during convulsions of animal prior to death). The other animals had eaten all their respective feeds and showed no symptoms.

(4) *Conclusions*—

(a) The toxic principles of the seeds of *O. parviflorum* are destroyed by, or are soluble in water.

(b) Less than 0·5 grams untreated seeds were toxic for a rabbit.

(c) Further experiments are necessary in order to determine nature of the action of water on the toxic properties of seeds.

Experiment No. 2 :

(1) *Purpose.*—To determine action of both tap and distilled water on the toxic principles of the seeds of *O. parviflorum.*

(2) *Details* -(a) Group 1., to test toxicity of seed residue after treating with tap water -Rabbits 34 and 35 each received 0·5 grams pulverised seeds previously soaked for four hours in 150 c.c. tap water at room temperature and washed well before being fed.

(b) Group 2, to test toxicity of tap water infusions- -Rabbits 36 and 37 each received half of filtered fluid from (a), *viz.* 71 c.c. each.

(c) Group 3, to test toxicity of seed residue after treating with distilled water—Rabbits 38 and 39 each received 0·5 grams pulverised seeds previously soaked for four hours as in (a), using distilled water.

(d) Group 4, to test toxicity of distilled water infusion- -Rabbits 40 and 41 received 76 c.c. each of filtered fluid from (c).

(e) Group 5, to control toxicity of untreated seeds -Rabbit 42 received 0·5 grams of untreated pulverised seed.

The experiment was commenced on 2 2 27.

(3) *Results* -3/2/27—

Group 1.—All feed eaten ; animals normal.

Group 2,—Feed partly eaten ; both animals dead.

Group 3, -Rabbit 38 died from other causes after leaving feed practically untouched.

Rabbit 39 : Feed all eaten ; animal normal.

Group 4.—Feed almost all eaten ; both animals dead.

Group 5. -Rabbit 42 dead ; 0·3 grams seeds eaten.

(4) *Conclusions.*—(a) The toxic principles of Box seeds are readily soluble in both tap water and distilled water.

(b) Aqueous infusions of seeds in either tap water or distilled water are highly toxic.

(c) The residue of powdered seeds after soaking for four hours in excess of either tap water or distilled water is apparently non-toxic (when given in small amounts much in excess of toxic dose of untreated seeds).

(d) In experiments to investigate the action of antidotes on toxic principles of *O. parviflorum* (and probably other plants) it will be necessary to feed the entire mixture of portions of plants, and fluids in which they are treated.

(N.B. This practise was followed in all subsequent experiments.)

Experiment No. 3:

(1) *Purpose.* To determine action of potassium permanganate on the toxic property of seeds of *O. parviflorum*.

(2 *Details.* (a) Group 1. Test animals. Guinea pigs 37 and 38, each received 0·25 grams pulverised seeds soaked for 4½ hours in 5 c.c. of a 1% solution of potassium permanganate in distilled water.

(b) Group 2. Controls Toxicity Potassium permanganate.—Guinea pigs 39 and 40 each received 5 c.c. potassium permanganate solution as above in ordinary feed.

(c) Group 3. Control Toxicity.—Guinea pig 41 received 0·25 grams of untreated seeds.

(N.B.—Guinea pigs 37-40 inclusive were all fed with approximately three-fourths of a grain of potassium permanganate each.)

The experiment was commenced on 3 2 27.

(3) *Results.* 4 2 '27 –

Group 1. Guinea pig 38 dead; 0·19 grams seed eaten.
Guinea pig 37 died; 0·05 grams seed eaten.

Group 2. No symptoms: both animals eaten three-fifths of their feed.

Group 3.—Guinea pig 41 dead; 0·07 grams seeds eaten.

(4) *Conclusions.* (a) The treatment of 0·25 grams pulverised seeds of *O. parviflorum* with 5 c.c. of a 1% solution of potassium permanganate in distilled water does not appear to make any material difference to their toxicity.

(b) The experiments should be repeated using larger quantities of potassium permanganate. The effect of potassium permanganate in acid solution should also be tried.

N.B.—These three experiments may be taken as a type of the further experiments which I do not propose to give in detail.

Experiment No. 4:

A prototype of Experiment No. 3, using 20 c.c. of potassium permanganate solution instead of 5 c.c.

(1) *Results.* As for Experiment 3.

(2) *Conclusions.* Potassium permanganate in neutral solution does not appear to have any detoxicant action on the toxic principles contained in seeds of *O. parviflorum*, as demonstrated by controlled experiments. Even when pulverised seeds are treated with an equal mass of potassium permanganate in neutral solution the toxicity of the seeds is not modified after 4½ hours soaking.

Experiment No. 5:

A prototype of Experiments Nos. 3 and 4 except that each 0·25 grams of seed were soaked for 3½ hours in 60 c.c. tap water in which was previously dissolved 0·3 grams of "Poison Plant Antidote Tablets." These tablets were supplied by Felton, Grimwade & Bickford, and are made according to Mann's formula; each tablet contains approximately 1·27 grams, and the dose recommended for sheep is one tablet. The results obtained were as in previous experiments; 0·08 and 0·09 grams of pulverised seeds, treated with antidote, were found to be toxic for guinea pigs.

Experiment No. 6:

A repetition of Experiment No. 5, with the difference that seeds were soaked for 4½ hours in antidote solution instead of for only 3½ hours.

The results obtained were identical with those obtained in Experiment No. 5, 0·1 grams treated seeds being found fatal for guinea pigs in this case.

Conclusions.—Experiments 5 and 6 show that "Poison Plant Antidote Tablets" (Mann's formula) have no detoxicant effect on the toxic principles contained in pulverised seeds of *O. parviflorum*, even when seeds are treated with a slight excess of tablet in solution.

N.B.—In these experiments the smallest quantity of untreated seeds proving fatal for guinea pigs was 0·09 grams. The smallest quantity of treated seeds was 0·05 grams.

4. Experiments with Gastrolobium bilobum.—"Heart Leaf Poison."

For details of source of plant specimens, etc. [*Vide* Section A., *G. bilobum*, Expt. No. 2].

The purpose of this experiment was as for *O. parviflorum* experiments 5 and 6 (*vide supra*). The technique used was identical.

Only one experiment was carried out with *G. bilobum*, using the same quantities of pulverised seeds and antidote ("Poison Plant Antidote Tablets") as in the *O. parviflorum* experiments. The period of treatment of seeds with antidote solution was four hours. The experiment was commenced on 9/3/27. *The result obtained* was as for *O. parviflorum* experiments 5 and 6: 0·14 and 0·07 grams of treated seeds of *G. bilobum* were found to be toxic for guinea pigs.

Conclusion.—"Poison Plant Antidote Tablets" (Mann's formula) have no detoxicant effect on the toxic principles of pulverised seeds of *G. bilobum*.

5. Experiments with Oxylobium tetragonophyllum:

For details of source of plant specimens, etc. [*Vide* Section A, this plant].

During my absence Filmer conducted an experiment to determine the effect of potassium permanganate on the toxic principles contained in this plant. He reports as follows:—"Wild rabbit weighing 1,077 grams:—6/8/26, 4 p.m., fed eight grams flowers and buds which had been soaked for five hours in a 1% aqueous solution of potassium permanganate, washed, ground and mixed with damp bran; 7·30 p.m., found dead, rigor mortis had set in; there were signs of struggling; 4·0 grams of flowers and buds had been eaten."

Conclusion.—Toxicity of flowers and buds of *O. tetragonophyllum* was not removed by soaking in 1% aqueous solution of potassium permanganate for five hours and washing. It would further seem doubtful if potassium permanganate will prove effective as an antidote in cases of poisoning with this plant.

6. Experiments with Gastrolobium calycinum —"York Road Poison."

As already mentioned, it was for cases of poisoning of stock with this species that Mann originally recommended the potassium permanganate treatment. The grounds on which he based his recommendations are as follow :—

(1) The isolation of a toxic alkaloid cygnine from this plant which when injected subcutaneously in small doses produced symptoms (and death) in guinea pigs resembling those obtained when the plant was fed.

(2) *Chemical Test.* —"Theoretically, therefore, it is a case peculiarly suitable for the application of the permanganate treatment, and this has been confirmed by the following practical test made in the laboratory :—"Half a pound of the powdered York road plant was treated with slightly acid water in order to extract the alkaloid, and then to the mixture of extract and solid material was added 10 grains of permanganate of potash. This was instantly de-colourised, showing that it had oxidised some substance present, and when tested immediately after the extract gave no tests for alkaloid showing that the latter had been destroyed even in the presence of a large quantity of other organic matter."

(Quoted from Mann, Journal of Agriculture, W.A., Vol. XII., 1905, p. 560.)

A similar experiment was also done by Mann with Box Poison, with the same result—destruction of alkaloid.

(3) The results of treatment of stock in the field as reported by stock-owners and others. The instances quoted by Mann would tend to support the potassium permanganate treatment but the numbers of cases treated are small and the tests are uncontrolled, therefore inconclusive.

It was felt that experiments with York Road poison were required to complete the work in this section, but seeds of this plant had not been obtainable when wanted. However, thanks to the courtesy of Mr. Wickens, of this Department, supplies of young shoots have been available. The effect of antidote on those has been tried.

(4) *Experiments*

(a) Source of material.—Mundaring.

(b) Nature of material.—fresh green suckers with young shoots.

(c) Date received.—29/7/27 ; tested 29/7/27 and 30/7/27.

(d) *Details.*—Two experiments were carried out identical with those previously described in this section, except that finely chopped young terminal shoots of suckers were used instead of seeds. In the first experiment the dose used was 3·0 grams and in the second experiment, 6·0 grams. The test animals received leaves soaked for five hours in the antidote tablet solution in the first experiment, $4\frac{3}{4}$ hours in the second. Guinea pigs were used as experimental subjects.

(5) *Results.*—The results obtained were similar to those with the other plants in this section.

In Experiment No. 1 both test animals succumbed, having eaten all feed. The guinea pig used as a control of toxicity ate all the feed and was very sick for two days, showing similar symptoms to the others, but recovered on the third day.

In Experiment No. 2 an identical result was obtained—the two test animals succumbed after eating 2·6 and 2·0 grams plant respectively ; the control of toxicity, considerably heavier than any of the others, ate 4·3 grams and was affected with acute symptoms, but subsequently recovered.

(6) *Conclusions.*—(a) Solutions containing five grains (0·3) of "Poison Plant Antidote Tablet" were found to have no appreciable detoxicant effect on the toxic properties of 45 grains, = 3 grams (in two cases) and 90 grains = 6 grams (in two cases) of finely divided shoots of *G. Calycinum* even when in intimate contact for approximately five hours. The toxicity was determined by feeding tests.

Mann, as quoted, states that 10 grains of potassium permanganate destroyed all traces of alkaloid contained in half a pound of leaves of *G. Calycinum.* The plant used by Mann was probably considerably less toxic than shoots used in my experiments, but the organic matter (which might oxidise the potassium permanganate) present in these tests is negligible when compared with that in Mann's experiment.

(b) It does not appear that "Poison Plant Antidote Tablets" (or potassium permanganate) are likely to be of value as antidotes in cases of poisoning with *G. Calycinum.*

General Conclusions—Section C.

1. The effect of the action of potassium permanganate on the toxic principles contained in plants representative of the genera *Gastrolobium* and *Oxylobium* has been tested as detailed above. The potassium permanganate has been used either in neutral solution or in acid solution in form of "Poison Plant Antidote Tablets" (Mann's formula).

2. It would appear that *in vitro* potassium permanganate has no detoxicant action on the toxic principles contained in the plants *Oxylobium parviflorum, Oxylobium tetragonophyllum, Gastrolobium bilobum* and *Gastrolobium calycinum.*

3. It does not appear probable that potassium permanganate will be of much value as an antidote in cases of poisoning with *O. parviflorum, O. tetragonophyllum, G. bilobum* and *G. Calycinum*, having failed in *in vitro* tests where every opportunity was given for its action to be manifested. On present evidence it appears that the recommendation of potassium permanganate, even in form of "Poison Plant Antidote Tablets," as an antidote in cases of poisoning of stock with plants of the genera *Oxylobium* and *Gastrolobium* is unwarranted.

4. The toxic principles contained in seeds of *O. parviflorum* have been shown to be very soluble in tap water and distilled water; the same probably applies to *G. bidens* and possibly to other poisonous members of the genera *Oxylobium* and *Gastrolobium.*

Acknowledgment.—I desire to thank Messrs. Carne and Gardner, of the Botanical Branch, for their assistance in diagnosis and collection of plant specimens, and in many other directions, also Mr. Filmer (Veterinary Officer, Fremantle) for many helpful suggestions and for carrying out experiments with *O. tetragonophyllum.*

By Authority: Fred. Wm. Simpson, Government Printer, Perth.

3. ADDITIONS TO THE PLANT DISEASES OF SOUTH WESTERN AUSTRALIA,

BY

W. M. Carne, F.L.S.

Department of Agriculture.

(*Read 13th September, 1927. Published 14th December, 1927*).

This paper adds to the list of diseases previously given (*vide* Proceedings Roy. Soc. W.A., Vol. XI., pp. 43–68, 1924–5) and includes a few corrections. The method of setting out the records previously used has been followed.

Occurrence is indicated by—

VC very common.
C common.
O occasional. Occurring most years but not plentifully.
R rare.

Importance-

4. Very serious, leading to severe loss.
3. Serious and warranting control measures.
2. Not normally serious and control measures not generally warranted.
1. No economic importance.

Season of Occurrence—

W Wet season (Apl. or May to Sept. or Oct.).
W (Spring) Sept. to end of wet season.
W (Autumn)—May to July.
D Dry season (Oct. or Nov. to March or April).
D (early summer)—Oct. to Dec. Usually indicates that the disease is associated with summer rains.

References. Unless otherwise stated all references are to the Journa of Agriculture of W.A. (Second Series).

Fruit Trees.

POME FRUITS.

Ripe or Bitter Rot ...	Glomerella cingulata (St.) Sp. & v. S. Apple, pear and quince fruits. O. 2. W (Autumn)
Alternaria Fruit Rot	Alternaria sp. } Common storage rots.
Blue Mould	Penicillium expansum Lk. } Common storage rots.
Deep Scald of Apples	Occasional trouble in cold stores, principally on Dunn's.
Bitter Pit of Pears and Quince	R. 3–4. D (Vol. 4, p. 204, 1927).
Lithiasis of Pear	R. 2–3. D. (Vol. 4, p. 202, 1927).
Fasciation of Apple	Non-parasitic. O.1.D. Apparently confined to central fruits of clusters.
Proliferation of Apple	Non-parasitic. R.1.D.

Dieback of Pears	Non-parasitic. O.4.D. W (Spring) and D (early summer). Locally known as "fire-blight." Young shoots are affected in spring as by fire. Trees recover later in summer. Due principally to bad drainage.
Dieback of Apples	Non-parasitic. C. 2–3. D. Associated with poor gravelly soils with a tendency to dry out in the summer.
Bordeaux Fruit Russet Injury	Non-parasitic. Due to the use of Bordeaux or Burgundy Mixtures at pinking stage or later.

STONE FRUITS.

Crown Gall	Pseudomonas tumefaciens. Smith & Town. On Japanese plums, Queen's Park, 1926; Bassendean, 1927.
Calyx Rot of Apricots	Sclerotinia sclerotiorum (Lib.) Mass. Recorded in previous list as due to Monilia. Attacks the young fruit during wet weather between setting and the falling of the perianth. Known only in the Upper Swan District.
Shot Hole of Cherry	Clasterosporium carpophilum (Lev.) Aderh. Recorded previously on apricot, almond, plum and peach. Jardee. Nov., 1926.
Schizophyllum commune Fries	A wound parasite common on sunburnt and partially dead branches of stone fruits.
Dieback of Apricot	Cause unknown. Dieback is preceded by a discoloration of the wood. Kelmscott, 1926.
Fruit Gummosis of Japanese Plum	Known only on variety "Rubio" at Mahogany Creek where it has caused a total loss in Jany. 1926 and 1927. Portion of the fruit becomes water-logged and brown, and a gummy sap exudes on the surface. Probably physiogenic.
Oil Spray Injury	Non-parasitic.

CITRUS FRUITS.

Brown Rot.	Phytophthora (Pythiacystis) citrophthora (Sm. & Sm.) Leonian. R. 3–4. D (autumn). Found in May, 1926 following exceptional rains in April. Active until mid-June. Not found in 1927. Attacks fruits of all citrus, but the leaves only to a minor extent. Not distinguishable in field from next disease, except by the absence of severe leaf and twig attack.
Brown Rot	Phytophthora hibernalis Carne. (Proc. Roy. Soc. W.A., Vol. XII., pp. 13–41, 1925–6). VC. 3–4. W. Recorded in previous list as Brown Rot of Oranges and Brown Rot of Lemons. Attacks fruit, leaves and twigs of citrus. Usually active from June to August.

Citrus Pit	Pseudomonas citriputealis (C.O. Sm.) Stev. (Vol. 3, p. 378, 1926) VC. 2–4 W. On lemons, mandarins and oranges in order of severity.
Dry lemons	R. 4. D. Physiogenic disease of unknown origin.

GRAPES.

Eel Worm	Caconema (Heterodera) radicicola (Greef) Cobb. North Perth, May, 1926.
Drought Spot	C. 1–2 D. Non-parasitic.

PASSION VINE.

Sclerotinia Foot Rot .	Sclerotinia sclerotiorum (Lib.) Mass. O. 4. D
Fusarium Foot Rot .. .	Fusarium sp. O. 4. D.

CAPE GOOSEBERRY.

Fruit Rot	Ascochyta sp. C. 3–4. W & D (early summer).
Foot Rot	Rhizoctonia bataticola (Taub.) Butler, O. 4. W & D.
Proliferation	Non-parasitic.

WALNUT.

Anthracnose	Pseudomonas juglandis Pierce. Bridgetown, Feb., 1927.

OLIVE.

Anthracnose	Gloeosporium ? olivarum D'Alm.. Glen Forrest, June, 1927.

Vegetable Crops.

POTATO.

Mosaic	Virus Disease. C. 3. W (Spring) and D (Early summer). Vol. 4, p. 322, 1927. All seed, except strains from Albany-Denmark line, upwards of 100% affected.

BEANS.

Rhizoctonia Foot Rot of French Bean	Macrophomina phaseoli (Maubl.), Ashby, South Perth. December, 1925. Both Macrophomina and Rhizoctonia bataticola stages present.
Sclerotium Foot Rot of French Bean	Sclerotium Rolfsii Sacc. O. 3–4, D.

LETTUCE.

Bacterial Soft Rot	Bacillus sp. Perth, December, 1925.
Grey Mould	Botrytis cinerea Pers. Arrino, August, 1926.

CRUCIFERS.

Oedema of Cauliflowers	Non-parasitic. Belmont, August, 1925.
Pink Mould of Cauliflower	Cephalothecium roseum Cda. Capel, November, 1925.

MELONS.

Water Melon Wilt	Fusarium ? niveum E.F.S. O. 3–4. D. Serious on land where melons have been grown several years in succession.

Cereal Diseases.

WHEAT.

Yellow Bacterial Disease	Pseudomonas tritici Hutch. R. 4. W. and D (Early Summer). Disease appears only as plants head. Known only from Yelbini. Associated with Tylenchus tritici. See Agric, Journal W.A., 3. 512, 1926.
Pleosphaeria Seedling Blight	Pleosphaeria semeniperda. Britt. & Adam, Merredin, 1926. Kills seeds in soil and seedlings or stunts plants.
Leaf Rust	Puccinia triticina Friks. O. 1–3. W (Spring). Common, 1927.
Leaf Spot	Septoria tritici. Desm. Recorded in previous list as P. gramineum. VC. I. W & D.
Foot Rot	Helminthosporium sativum, P.K. & B. Bullfinch, October, 1926. Merredin, July, 1927.
Brown Point of grain	Penicillium sp . Macrosporium sp., and Cladosporium sp. Common when rain occurs on ripening or ripe crops. Affects germination more or less.
Pink Spots on Wheat Grains	? Coniothecium sp. Associated with rain on ripening or ripe crops. Mainly in Northern wheat belt. Germination more or less affected.
Seedling Blight	? Coniothecium sp. Merredin, July, 1927.
Grey Speck of Oats and Wheat	Cause not determined. 1–4. W. Locally called " White Wilt." Identical with the " Roadside Take-all " oat disease of South Australia. Mainly around Narrogin, but extending at least North to Beverley, East to Kulin and South to Broome Hill. Associated with gravelly and powdery soils carrying White Gum and Mallet. Plants recover if conditions favourable when warm weather sets in. Controlled by dressings of manganese salts plus sulphate of ammonia.
Malformation of Tillers	Due to adhesion of lower leaf sheaths and blades. Merredin State Farm, August, 1926, and in pot experiments at Perth. Stated by E. J. Limbourn, the officer in charge of cereal breeding at Merredin, to be common in Merredin and other Federation crossbreds.

BARLEY.

Stem Rust	Puccinia graminis Pers. O. 1. W (Spring) and D (Early Summer).
Pink Stem Disease	? Coniothecium sp. Beverley January, 1925. Associated with the same fungus as found with pink spotted wheat grains.
Leaf Stripe Disease	Pleospora sp. O – C. 1–2. W. More serious on seedlings than older plants.

OATS.

Pleosphaeria Disease .	Pleosphaeria semeniperda Britt. & Adam. Associated with a leaf stripe. Beverley, September, 1926.
Take-all	Ophiobolus cariceti (Berk & Br.) Sacc. Belka, September, 1927.
Leaf Spot	Helminthosporium avenæ. Eidam. C. 1–2. W.
Grey Speck	See wheat. 2–4. W.

SORGHUM.

Covered grain smut	Sphacelotheca sorghi (Lk.) Clint. Kaffir Corn, Jardee, March, 1926; Broom Millett, Yarloop, July, 1927.

MISCELLANEOUS CROP PLANTS.

JAPANESE MILLET.

Grain Smut	Sorosporium ? panici miliacei (Pers.) Tak. Yarloop, July, 1927.

LUCERNE.

Rhizoctonia Disease	Rhizoctonia bataticola (Taub.) Butler, Midland Junction. January, 1925.

MISCELLANEOUS PLANTS NOT CROP PLANTS.

ASTER SP. (Michaelmas Daisy).

Mildew	Erysiphe cichoracearum D.C. Perth, May, 1927.

AVENA BARBATA Brot. (Yatheroo Oats.)

Rust	Puccinia coronata Cda. Perth, November, 1925.
Leaf Spot	Leptosphaeria avenaria Weber. South Perth, July, 1927.

DAHLIA SP.

Eelworm	Caconema radicicola (Greef), Cobb. C.

EHRHARTA LONGIFLORA Sm. (Annual Veldt Grass).

Leaf Spot	Pleosphaeria semeniperda, Britt & Adam. Carlisle, August, 1927.

GLADIOLUS SP.

? Mosaic .... O C. 4 D. + W.
Corm Rot. .... Fusarium oxysporum var. gladioli. L.M. Massey C. 3–4 D.

HORDEUM MURINUM L. (Barley Grass).

Leaf Spot .... Septoria passerinii Sacc. Nungarin, October 1926.

IRIS SP.

Selerotium Disease .... Sclerotium Rolfsii Sacc. Swan View, December, 1926.
Mosaic .... Swan View, December, 1926.

LATHYRUS ODORATUS L. (Sweet Pea).

Leaf Spot .... Ascochyta sp. O.W.
Foot Rot .... Corticium vagum B. & C. Bayswater, February, 1927.
Broom Rape .... Orobanche cernua Loefl. Perth, September, 1926.

LOLIUM PERENNE L. (Perennial Rye Grass).

Rust .... Puccinia coronata Cda. South Perth, November, 1925.

PAPAVER NUDICAULE L. (Iceland Poppy).

Phytophthora Rot .... Phytophthora sp. C. 3–4 W.

PASSIFLORA EDULIS sims (Passion Fruit).

Eelworm .... Caconema radiciola (Greef) Cobb. Common around Perth.

PINUS SP. (Pine Trees).

Root Rot .... Pleurotus lampas Berk. Coolup, June, 1926,
Nursery Fungus .... Thelephora terrestris Ehrh. Gnangara, September, 1926. Non-parasitic.
Curly Needle . .. . Cause unknown. Bickley, November, 1926.

SENECIO VULGARIS L. (Groundsel).

Rust .... Puccinia tasmanica Diet. Kelmscott, September, 1927.

SISYMBRIUM ORIENTALE L.

White Rust .... Albugo candida (Pers) Rouss. Merredin. September, 1926 and June, 1927.

STIPA. SP.

Smut .... Cintractia hypodytes (Sch.) Diet. Goomalling, November, 1925,

VIOLA TRICOLOR L. (Pansy).

Eelworm .... Caconema radicicola (Greef) Cobb. Perth, August, 1926.

By Authority: Fred. Wm. Simpson, Government Printer, Perth.

4.—AUSTRALIAN FORMICIDAE.

By John Clark, F.L.S.,
Entomologist, National Museum, Melbourne, Victoria.

Communicated by L. Glauert, B.A., F.G.S.

(*Read* 17*th April*, 1928. *Published* 24*th April*, 1927.)

The ants dealt with in the present paper are of more than usual interest. The majority of them belong to rare and primitive groups. Undoubtedly the most interesting is the one herein described as *Lithomyrmex glauerti*, gen. et sp. n.). This remarkable ant was found by Mr. L. Glauert amongst the fossil beds at the Irwin River. At first sight this is easily mistaken for a species of *Amblyopone*, but the characters of the head and legs indicate that it is really nearer to the genus *Onychomyrmex*, Emery, and forms a connecting link between them. At present the genus *Onychomyrmex* constitutes a tribe, *Onychomyrmicini*, quite apart from the *Amblyoponini*. A careful comparison of the species of *Amblyopone* and *Onychomyrmex* in my collection with *Lithomyrmex* suggests that the latter be placed near *Onychomyrmex* and that both be placed under the tribe *Amblyoponini*. The fact that the females of *Onychomyrmex* are ergatoid, or worker like, is of little importance in this matter, as species of various genera and tribes contain both winged and ergatoid females (*Myrmecia*, *Rhytidoponera Phyracaces*, etc.). They are very primitive ants and through the ages have led a more or less hypogaeic existence. Departures from the normal type of head and legs are to be expected when we consider the various classes of country in which these ants are found. Some live in rough, rocky ground, in which case we find short thick-set legs, and short strong claws; others, living in soft sandy places have normal legs and claws; whilst *Onychomyrmex*, which appear to inhabit mostly the interior of rotten logs, have long legs and very long claws.

The wing venation is remarkable in that it exhibits a vein not known to exist in any ant hitherto described. This vein, corresponding to M2 of Tillyard's notation, is shown on the accompanying plate. On submitting photographs of this wing to Dr. Tillyard, he replied (in litt.): "The extra stump vein marked by you with a cross is obviously M2; see my figure of *Perga*, for instance, which has this vein in almost exactly the same position. It is most remarkable that any ant should possess this vein, because, of all known Hymenoptera, only the Family *Xyelidae* and the genus *Perga* (stump only) possess it. That is to say, the ants must go right back almost to the very beginning of the order. Another interesting point about your photograph is that the blackish pterostigma is a very primitive form, and is completely surrounded by main veins, as the photographs clearly show. This comes very close to the primitive forms shown in the genus *Syntexis*, which is about half-way between the *Cephidae* and the *Xiphriidae*. The lower vein, which encircles the stigma posteriorly, is the true radial sector while the upper one, which runs along the costa, to meet it, is the main stem of the radius."

Another feature in connection with the wings is that the veins show indications of having been continued, almost to the apex of the wing, they are represented now by obsolete markings.

The wings of most species of *Amblyopone* clearly show the pterostigma encircled by the veins, particularly so in *Amblyopone aberrans*, Wheeler, from Western Australia. The wings of *A. saundersi*, Forel, of New Zealand, have almost identically the same venation as *A. aberrans*.

Recently, Dr. Wheeler has revised the genus *Amblyopone*; unfortunately, whilst giving a good key to the species, he has omitted to give a generic diagnosis. The species he describes as *A. hackeri* is congeneric with *Stigmatomma saundersi* Forel, which is certainly not a *Stigmatomma*. I recently received a number of specimens of both workers and females from Dr. Tillyard and Mr. E. S. Gourlay, of New Zealand. This group of *Amblyopone* is apparently well represented in Australia, there being several undescribed species in my collection. A few are herein described.

Whilst collecting Lepidoptera recently in Cape York, Mr. W. B. Barnard of Toowoomba, sent me a fine collection of ants from that locality. This contained examples of a very large *Polyrhachis*, herein described as *Polyrhachis barnardi*, n. sp. One specimen was found securely attached to a leaf on a tree, by a peculiar species of fungus, probably *Cordyceps*. This is being investigated by Dr. Ethel McLennan, of the Melbourne University.

Sub-family PONERINAE Lepeletier.

Tribe Amblyoponini, Forel.

Genus Lathomyrmex Gen. Nov.

Worker. Monomorphic; mandibles long and narrow, with long, curved, acute tips, their inner borders armed with strong teeth, those at the middle very long and directed backward. Maxillary and labial palpi short, 2-jointed. Clypeus moderately short, strongly rounded, the anterior border with a row of small sharp points, or denticles. Frontal carinae small, closely approximated, dilated in front, separated by a very narrow groove. Eyes small, placed behind the middle of the sides of the head. No ocelli. Antennae 12-jointed; scapes greatly enlarged towards their apex; funiculus gradually thickened towards their apex. Thorax slender: mesonotum narrow, tranverse. The sutures of the thorax very distinct. Petiole with a very short peduncle in front, the posterior face articulated on its whole width with the postpetiole the latter broad and convex, separated from the gaster by a strong constriction. Legs long and slender, with one spur on each tibia, those on the middle tibia being slightly smaller than the others. Claws large, curved and simple; pulvilli moderately large.

Female. Winged. Similar to the worker, but with larger eyes, and three large ocelli. The gaster is much larger. Wings with one closed cubital cell; radial cell closed; vein M2 present.

Male. Mandibles small and narrow. Frontal carinae short. Antennae long, slender, 13-jointed; scapes slightly longer than the first two joints together. Eyes and ocelli large. Mesonotum with deeply impressed mayrian furrows. Genitalia retracted. Cerci absent. Legs slender with one spur on each tibia. Wings with one cubital cell; radial cell closed. Vein M2 present.

Genotype Lithomyrmex glauerti, n. sp.

This genus is half-way between *Amolyopone* and *Onychomyrmex*. In *Amblyopone* the frontal carinae are widely separated, and the legs have one or two spurs on each tibia. In *Onychomyrmex* the frontal carinae are closely approximated, the front and middle tibia have each one spur, and the hind tibia has no spurs.

Lithomyrmex Glauerti, n. sp.

(Pl. I., figs. 1-11.)

Worker. -Length 5--6mm.

Reddish brown, legs paler, almost testaceous. Hair yellow, short, suberect, longer and more abundant on the apical segments of the gaster than elsewhere, short and adpressed on the antennae and legs. Pubescence yellowish confined to the antennae and legs, where it is very fine and close lying.

Shining. Head finely and sparsely punctate; mandibles coarsely punctate, the punctures shallow and somewhat elongated. Thorax with a few scattered, shallow punctures, sightly coarser on the epinotum than on the pronotum. Petiole and gaster with fine, scattered, shallow punctures, and in addition with a close microscopic reticulation.

Head slightly longer than broad, as broad in front as behind, the occipital border and sides convex, the posterior angles strongly rounded. Frontal carinae short, approximated, separated only by a narrow groove, truncate behind. Carinae of the cheeks very short. Clypeus short, broadly rounded in front and above, the anterior border armed with small denticles. Eyes small, placed behind the middle of the sides. Ocelli absent. Mandibles long and narrow, abruptly bent at their base; the external border concave in the middle, the points strongly curved inwards; the inner border convex, armed with seven unequal teeth, excluding the point of the mandible, the two at the middle are longest and strongly hooked backward. Antennae robust, the scapes extend beyond the hind margin of the eyes, constricted in the middle, and much thicker at the apex than at the base; first joint of the funiculus longer than broad, second to tenth as long as broad, the apical joint bluntly pointed and longer than the two preceding joints together. Thorax fully twice as long as broad; pronotum slightly broader than long, strongly convex in front and on the sides; mesonotum small, four times broader than long; epinotum longer than broad, broader behind than in front, without a defined margin between the dorsum and the epinotal declivity, the latter short, and at an obtuse angle; petiole broader than long, strongly convex in front and on the sides, the anterior face almost vertical, the posterior face articulated on its whole width with the postpetiole; in profile it is feebly rounded and convex above, the dorsum merging into the anterior face by a strong curve, the ventral surface with a broad tooth-like projection in front. A deep constriction between the petiole and postpetiole, the latter is almost twice as broad as long, with evenly convex sides. A moderately deep constriction between the postpetiole and gaster. First segment of the gaster broader than long, and slightly broader behind than in front. Legs moderately long and slender, all the tibiae armed with one large pectinate spur; claws long and simple; pulvilli large.

Female. Length 6 mm. (Winged.)

Resembles the worker but is larger and more robust. The head is longer, and much broader behind than in front. The eyes slightly larger, and with three well developed ocelli. Thorax fully twice as long as broad. Wings hyaline, their tips not extending to the apex of the gaster; with one cubital cell. Vein M2 present, as a stump only.

Male. Length 6 mm.

Black. Mandibles, antennae and legs brownish, apical joints of the antennae and tarsi lighter.

Hair yellow, short and moderately abundant on the head and body, longer and more numerous on the apical segments of the gaster. Pubescence greyish, particularly on the gaster, very short and adpressed on the antennae.

Shining. Head with a few large, scattered, shallow punctures in front. Mandibles punctate. Pronotum slightly rugose. Mesonotum smooth, with small scattered punctures in front, and large scattered punctures behind. Scutellum also with scattered shallow punctures. Epinotum irregularly rugose. Petiole densely punctate. Postpetiole and gaster with small scattered punctures.

Head as long as broad, almost circular. Frontal carinae obsolete; there is a faint median impression on the centre of the forehead, extending to the anterior ocellus. Clypeus broadly rounded in front, rounded and convex above. Eyes very large, placed in front of the middle of the sides. Ocelli large. Mandibles small and sharply pointed Antennae robust, 13-jointed; scapes slightly longer than the first two joints of the funiculus together, enlarged at the apex, their insertions exposed; all the joints of the funiculus longer than broad. Pronotum narrow, convex and rounded in front and on the sides. Mesonotum as long as broad, broader behind than in front, mayrian and parapsidal furrows deeply impressed. Scutellum slightly broader than long, convex and rounded. Epinotum broader than long. Wings hyaline, not extending to the apex of the gaster; with one cubital cell; vein M2 present, as a stump only. Petiole broader than long, the anterior border strongly convex; in profile it is rounded and convex above, the anterior face almost vertical; the ventral surface with a long blunt tooth-like projection in front. Postpetiole and all the segments of the gaster broader than long. Cerci absent. Genitalia retracted. Legs long and slender, all the tibiae have one spur each; claws long and simple.

Hab.:—Western Australia, Irwin River, August 1926 (L. Glauert).

Types in the Western Australian Museum.

Described from four workers, one female and one male. A half grown larva was also found, but not in condition to be described. They were found under a stone, on the fossil beds at the Irwin River, by Mr. L. Glauert, to whom the species has been dedicated.

Amblyopone michaelseni, Forel.

Forel, Fauna Sudwest-Australiens 1, p. 264, 1907, *worker;*
Emery, Gen. Insect., Fasc. 118, p. 26, 1911, *worker;*
Wheeler, Proc. Amer. Acad. of Arts & Sc., vol. 62, 1, p. 18, fig. 4, 1927, *worker.*

Female. Length 11-12.3 mm. (Not previously described.)

The body is slightly darker than that of the worker, almost black. Mandibles, head, to the occipital third, and the antennae castaneus; legs and apical segments of the gaster more yellowish.

The head is longer than broad and scarcely narrowed behind. The occipital border is more concave and the angles more prominent. The eyes and ocelli are large. The thorax is smooth and shining, with a few small shallow punctures. The node is one-fourth broader than long, the base and the sides more densely and coarsely punctate. The postpetiole and gaster densely covered with piligerous punctures. Wings with a slight brownish tinge, veins and stigma brown.

Hab. : Western Australia, Jarrahdale (J. Clark).
Victoria, Glenrowan (in National Museum Collection).

The female in the National Museum differs from the type only in having the wings slightly lighter, more hyaline.

Workers of this species have also been received from the following additional localities:

Victoria, Buxton (R. Blackwood).
New South Wales, Bogong (in Macleay Museum Collection).

Amblyopone mandibularis, n. sp.

(Pl. I., figs. 12-15.)

Worker. Length 4.5-5.6 mm.

Castaneus, mandibles slightly darker, teeth black. Antennae and legs reddish yellow.

Hair yellow, short and suberect on the head and thorax, longer and more abundant on the gaster, very short and adpressed on the antennae and legs.

Shining. Dorsal surface of the mandibles longitudinally striate, with a few small punctures between the striae and a row of large punctures at the base of the teeth. On the ventral surface, they are concave and longitudinally striate. Clypeus finely longitudinally striate, the striae ascending into the frontal area. Head, in the middle, longitudinally striate, with a row of punctures between the striae; on the sides, in front of the eyes. It is more rugulose, almost reticulate in the antennal depression. Pronotum longitudinally striate, with a row of punctures between the striae as on the head, the striae arched, following the contour of the sides of the pronotum. Mesonotum and epinotum smooth and shining, with a few scattered shallow punctures. Sides of the thorax very finely and irregularly striate, longitudinally on the pronotum and obliquely on the meso and epinotum. Node, postpetiole and gaster with numerous shallow piligerous punctures.

Head as long as broad, slightly broader in front than behind, the sides almost straight, the posterior border concave and the angles rounded, the anterior corners ending in a sharp tooth-like projection directed forward.

Clypeus broadly rounded in front, and with a row of small sharp denticles. Frontal carinae moderately widely separated. Frontal area large. Frontal groove obsolete, hardly indicated behind the posterior limit of the carinae. Eyes very small, placed at the posterior third of the head. No ocelli. Mandibles much shorter than the head, the external border concave, ending in a long sharp point, inner border strongly convex and armed with eleven teeth, excluding the point of the mandible; the second, third and sixth are long and sharp, the first and fifth being somewhat smaller, the fourth very small but equal in size to the five small teeth near the base; all are directed slightly backward. Antennal scapes not quite extending to the eyes, slightly thicker at the apex than at the base; funicular joints one to seven longer than broad, nine and ten as broad as long, the apical joint longer than the two preceding joints together. Thorax barely twice as long as broad. Pronotum broader than long, strongly convex in front and on the sides, feebly rounded on top. Mesonotus much broader than long. Epinotum as broad as long, broader behind than in front, face of the declivity abrupt, borders of the latter and the dorsum submarginate. Petiole barely twice as broad as long, broader in front than behind, the anterior border almost straight, the sides convex, rounded and convex above, the ventral surface in front with a long translucent projection which is twice as long as it is broad, feebly directed backward. Postpetiole broader than long, and much broader behind than in front, without a protuberance on the ventral surface in front. First segment of the gaster as broad behind as in front. Legs short and stout.

Hab. : Victoria, Altona (F. P. Spry); Belgrave (F. E. Wilson); Eltham (J. E. Dixon); Cheltenham (C. Barrett, L. B. Thorn).

Described from a small colony from Belgrave. This species is close to *A. clarki*, Wheeler from W. Australia. It is readily distinguished by the mandibles which are striate on the underside. The basal teeth on some examples are partly in two rows. The frontal carinae are not so widely separated.

Type in the National Museum.

Amblyopone wilsoni, *n. sp.*

(Pl. I., figs. 16-19.)

Worker. Length 3 mm.

Yellowish red. Mandibles, antennae and legs lighter. Teeth black.

Hair yellow, moderately abundant throughout, short and adpressed on the antennae and legs. Pubescence short and close lying, particularly on the antennae.

Head densely and finely rugose, slightly coarser behind than in front. Mandibles longitudinally and irregularly striate, with a few elongate shallow punctures between the striae. Scapes somewhat coarsely punctate. Pronotum densely covered with large shallow punctures. Mesonotum also densely punctate, but the punctures much coarser than on the pronotum. The punctures on the epinotum large and scattered. Node and postpetiole smooth and shining, with numerous small shallow punctures; all the segments of the gaster much more finely punctate.

Head longer than broad, very slightly broader in front than behind, the occipital border concave, the sides convex, the posterior angles rounded; there is a sharp tooth-like projection in front at the junction of the clypeus. Clypeus short, broadly rounded in front, with eight rather long sharp denticles, the two at the sides and the pair in the middle appear as broad bifid teeth. There is a small single tooth between these large ones. Frontal carinae short, very close together, almost meeting in front, diverging very slightly outward behind; in front, they overhang, but do not hide, the antennal insertions, these are exposed. Eyes and ocelli absent. Mandibles long and narrow, the external border concave in the middle, abruptly bent at their base and at the point which is long and sharp; the inner border convex, armed with seven teeth, the first long and simple, the second to the fifth long, broad and bifid at the apex, directed slightly backward, the sixth and seventh are simple and sharp, also directed backward, the seventh is slightly longer than the sixth. Antennae short and stout; scapes parallel, extending to the posterior third of the head; first joint of the funiculus as long as the three following joints together, the second longer than the third, the others subequal in length, the joints gradually increase in width from the second to the apical which is pointed and as long as the three preceding joints together. Thorax two and a third times longer than broad. Pronotum as long as broad, convex in front and on the sides: in profile, it is feebly rounded and convex above. Mesonotum twice as broad as long. Epinotum as long as broad, broader behind than in front, the epinotal declivity abrupt, the sides of the latter and of the dorsum submarginate. Node as long as broad, the anterior border convex, the sides nearly straight; in profile nearly flat above, the anterior surface vertical; there is a broad translucent tooth on the ventral surface in front, the posterior corner of the tooth is directed backward. Postpetiole broader than long and broader behind than in front, the sides strongly convex. First segment of the gaster broader than long and as broad in front as behind. Legs short and stout.

Hab. : New South Wales, Barrington Tops (F. E. Wilson).

This species is remarkably like *A. saundersi*, Forel. It is, however, abundantly distinct. The formation of the teeth of the mandibles and clypeus, and the shape of the node at once distinguish it from that species. With a magnification of sixty I can find no traces of eyes.

This species is dedicated to Mr. Wilson, who has collected many rare species of ants.

Amblyopone exigua, n. sp.

(Pl. I., figs. 20-23.)

Female. Length 3.8 mm. (deälated).

Head, gaster and legs testaceus, thorax darker.

Hair yellow, long and abundant on the node, postpetiole and gaster, short on the legs and antennae.

Shining. Head very finely reticulate-rugose, with some very fine striae in front. Mandibles coarsely and irregularly striate, the striae having a longitudinal direction, a few elongate shallow punctures between the striae. Scapes coarsely punctate. Pronotum, on the sides, with moderately large shallow punctures, widely scattered on the disc. The anterior third of the mesonotum densely punctate, the punctures finer than those on the pronotum, the posterior two-thirds more coarsely punctate and finely reticulate between the punctures. Scutellum and epinotum finely rugose. Node smooth and shining, with numerous small shallow punctures, particularly on the sides, much finer than on the pronotum. Postpetiole and gaster densely punctuate.

Head slightly longer than broad, and broader in front than behind, the sides and occipital border nearly straight, the posterior angles rounded, the anterior corners produced, tooth-like and directed forward. Clypeus broadly rounded in front, with eight rather long sharp denticles. Frontal carinae short, almost meeting in front, but diverging feebly outward behind, the top edges lobe-like and overhanging the antennal insertions. Eyes small, flattened, placed behind the middle of the sides of the head. Ocelli small but distinct, the anterior ocellus in a slight depression. Mandibles about two-thirds of the length of the head, the external border feebly concave in the middle, strongly bent inward and downward at the point which is long and sharp: the inner border convex, armed with seven teeth, the first and second are small, simple, and directed slightly forward, the third, fourth and fifth are large and bifid at the apex, forming double teeth, both points are sharp and directed backward, the sixth is similar but much smaller, the seventh is simple, short and broad, close to the base of the mandible. Antennae somewhat short and stout, the scapes extending to the middle of the eyes, much thicker at the apex than at the base; first joint of the funiculus longer than the second and third together, from the second to the tenth the joints are broader than long and gradually increase in thickness to the apical which is long and pointed, and as long as the five preceding joints together. Thorax fully twice as long as broad through the pronotum, the latter one-third broader than long, strongly convex in front and on the sides, feebly rounded above. Mesonotum as long as the pronotum, much broader in front than behind, strongly rounded laterally above; there is a well defined constriction between the pronotum and mesonotum, but between the latter and the scutellum, the constriction is hardly apparent. Wing stumps are present. Scutellum small, one and three-quarter times broader than long, almost flat above. Epinotum twice as broad as long, broader in front than behind, without a defined margin between the dorsum and declivity, the latter abrupt, with the sides feebly marginate. Petiole broader than long, broader behind than in front; in profile it is almost straight and flat above, the anterior face vertical; there is a broad flat tooth on the ventral surface in front, the bottom edge of which is rounded, ending in a feeble point behind. Postpetiole broader than long, broader behind than in front, the sides convex; there is a strong constriction between the postpetiole and gaster. First segment of the gaster broader than long, as broad in front as behind, with the sides evenly convex. Legs short and stout.

Hab.: Victoria, Belgrave (F. E. Wilson).

Amblyopone saundersi, Forel.

Mitt. Schweit. Ent. Ges., Vol. 8, p. 336, 1892. *Female.*

Stigmatomma saundersi, Dalla Torre, Cat. Hym., Vol. 7, p. 15, 1892; Emery, Gen. Insect. 118, p. 25, 1911. *Female.*

(Pl. I., figs. 24-29.)

Worker. Length (Not previously described.)

Reddish yellow, mandibles, antennae and legs testaceus. Hair yellowish, short, sub-erect, moderately abundant everywhere, but much longer and more abundant on the apical segments of the gaster. Pubescence very fine and close lying.

Shining. Head very finely and densely punctate-reticulate. Mandibles longitudinally striate, with scattered shallow punctures between the striae. Antennal scapes somewhat coarsely punctate-reticulate. Pronotum smooth and shining, with a few scattered shallow punctures on the disc. Mesonotum finely rugose. Epinotum smooth and shining, with a few scattered shallow punctures. Node and postpetiole smooth and shining. Gaster finely punctate.

Head very slightly longer than broad, broader in front than behind, the occipital border nearly straight, feebly concave, the sides straight to the occipital third, from there they are strongly rounded to the border; there is a short tooth-like projection in front at the junction of the clypeus. Frontal carinae very short and lobe-like, the top edge overhanging the antennal insertions. They are separated by a narrow groove, almost meeting in front and diverging gradually behind; the carinae scarcely reach to the top of the antennal depression behind. Clypeus short, the anterior border strongly rounded in front, this border has ten small teeth or denticles. Eyes small and flat, placed near the occipital third of the sides. No ocelli. Mandibles long and narrow, but not so long as the head, the external border feebly concave in the middle, from the apical third they are strongly rounded inward and downward, terminating in a long sharp point; the inner border strongly convex, armed with seven teeth, excluding the point of the mandible, the first two are small and sharp, the three following are large and broad, bifid at the apex, suggesting a double tooth (these bifid teeth are more distinct on some specimens than on others), from the third tooth the mandible is strongly reduced to the base, near the base is a very large, sharp simple tooth. Antennae short and stout, sub-clavate, the scapes not extending beyond the eyes, parallel, slightly bent near the apex; first joint of the funiculus as long as the three following joints together, it is also much broader, all the joints from the second to the apex gradually increasing in length and width to the apical, which is sharply pointed, and as long as the three preceding joints together. Thorax two and a quarter times longer than broad. Pronotum slightly broader than long, rounded in front and on the sides; the dorsum is nearly flat, feebly concave. Mesonotum broader than long, the sutures well defined. Epinotum longer than broad and broader behind than in front, the epinotal declivity abrupt, without a defined margin between the latter and the dorsum. Node as broad as long, convex in front and on the sides; in profile it is as high as long, the dorsal surface feebly convex, the anterior face straight, there is a moderately long sharp tooth-like process on the ventral surface in front. Postpetiole broader than long, much broader behind than in front, the sides convex; there is a well defined constriction between the latter and the gaster. First segment of the gaster broader than long and broader behind than in front. Legs rather short and stout, tibiae of the anterior legs with one spur each, each of the middle tibiae with two small bristle like spurs, and the hind tibiae have each one broad pectinate spur and one long bristle-like spur.

Female. Length 4.1-4.3 mm.

Closely resembles the worker from which it differs in having ocelli, larger eyes and well developed wings. The wings are hyaline; the radial cell closed.

Male unknown.

Hab. : New Zealand, Nelson (R. J. Tillyard, E. S. Gourlay); Governor's Bay (E. S. Gourlay).

Type worker in the Cawthron Institute, Nelson.

Discothyrea bidens, n. sp.

(Pl. I., figs. 30-31.)

Worker. Length 2.7 mm.

Head brown, thorax and node black, mandibles, antennae and legs testaceus, gaster brownish yellow.

Hair greyish, short and fine, sub-erect, more abundant on the gaster than elsewhere. Pubescence greyish, very fine and close lying, particularly on the antennae and legs.

Semi-opaque, mandibles shining. Head, thorax and node very finely and densely reticulate-punctate; gaster densely and finely covered with shallow punctures. Antennae and legs finely punctate.

Head one and-quarter times longer than broad, the occipital border and sides strongly convex, the posterior angles rounded. Mandibles short, triangular, edentate, ending in a sharp point. Clypeus produced in front, overhanging the mandibles, the anterior border convex, the sides straight and parallel. Frontal carinae erect, short truncate behind. Eyes large, flat, placed in front of the middle of the sides. Antennae short and thick, the scapes greatly thickened to the apex; first joint of the funiculus almost globular, as long as broad and as long as the second and third together, joints two to seven broader than long, apical joint twice as long as broad, pointed, as long as all the other joints of the funiculus together. Thorax short, one and two-thirds times as long as broad, without traces of sutures; the pronotum convex in front and on the sides. Epinotum much narrower than the pronotum, the posterior border widely emarginate in the middle, forming two broad flat triangular tooth-like projections which are directed upward; epinotal declivity abrupt and straight, feebly margined on the sides. Node almost twice as broad as long, broader behind than in front, the anterior and posterior borders straight, the sides convex; in profile the node is twice as high as long, the anterior face inclined backward, the dorsal face short and strongly rounded into the anterior and posterior faces; there is a short sharp tooth on the middle of the ventral surface below. Postpetiole slightly broader than long, broader behind than in front, the anterior border short and strongly convex; in profile strongly rounded and convex above. A deep constriction between the postpetiole and first segment of the gaster, the latter is broader than long; the apical segments small and placed below. Legs short and stout.

Hab. : Victoria, Warburton (F. E. Wilson).

This species is readily separated from *D. crassicornis*, Clark, by its larger size, very large eyes, and by the posterior angles of the epinotum which are tooth-like and directed upward.

Sub-family DORYLINAE. Leach.

Genus Aenictus Shuckard.

Aenictus hilli, n. sp.

(Pl. I., figs. 32-36.)

Male. Length 8 mm.

Yellow, occipital border of the head and the eyes dark brown. Hair yellowish, very fine, long and pointed, abundant on all the body.

Shining. Head, thorax, node and gaster densely covered with fine shallow punctures. The mandibles with somewhat coarser punctures.

Head small, twice as broad as long, occipital border rounded and convex. Mandibles slightly longer than the head, broad, flattened and abruptly bent at their base, tapering to a sharp point in front, the inner border concave, edentate, the outer border convex. Clypeus very short and concave. Eyes very large, convex, occupying all the sides of the head, the facets feebly impressed, the eyes appearing smooth and shining. Ocelli large and globular, the posterior pair placed on the occipital border. Scapes of the antennae very broad and flattened, five times broader than thick, as broad as long; funiculus swollen in the middle, tapering to the base and to the apex; first joint as long as broad, second to tenth broader than long, the two apical joints longer than broad. Thorax fully one and two-thirds longer than broad; in profile it is very high, the pronotum and the epinotum descending almost vertically from the dorsum. Pronotum short, strongly rounded and convex in front and on the sides, scarcely visible from above, the thorax appearing to be composed of the mesonotum and scutellum. Mesonotum longer than broad, strongly convex in front and on the sides, rounded and convex above, parapsidal furrows distinct, mayrian furrows not present. Scutellum broader than long, strongly rounded and convex, almost globular, overhanging the epinotum, the latter forming an abrupt declivity. Wings hyaline, rather long, veins brown; with one discoidal cell and radial cell closed, the veins continued to the apex of the wing. Node broader than long and broader behind than in front, the anterior and posterior borders concave, the sides convex, the dorsum deeply concave in the middle, the concavity descending almost to the short petiole behind; in profile the node is higher than long, the anterior face and border of the dorsum convex; the ventral surface is produced into a long broad tooth, occupying almost the full area, directed backward. Postpetiole much broader than long, convex in front, the sides almost straight. The gaster large, long and cylindrical, the apical segments bent downward. Genitalia retracted. Legs short and slender; femora of all the legs flattened, about four times broader than thick.

Hab.: North Queensland, Malanda (G. F. Hill).

This is the first male of the genus to be described from Australia. Workers of three species have previously been recorded.

Sub-family FORMICINAE, Lepeletier.

Polyrhachis (Myrmhopla) barnardi, n. sp.

(Pl. I., figs. 37-38.)

Worker. Length 12-12.5 mm.

Black. Mandibles, antennae, coxae and femora brown, tibiae and tarsi with a violet sheen.

Hair greyish, erect, moderately long and abundant on the whole body, much shorter on the antennae and legs. Pubescence silvery on all the body except the gaster, there it has a yellowish tinge, abundant and close lying, almost completely hiding the sculpture of the clypeus, parts of the head, the node and gaster.

Mandibles smooth and shining, the rest of the body opaque. Mandibles with scattered shallow piligerous punctures. Clypeus microscopically reticulate. Front of the head longitudinally rugose, the occiput coarsely and irregularly rugose. Pronotum and mesonotum coarsely and irregularly

rugose, similar to the occiput. Dorsal surface of the epinotum microscopically reticulate, the declivity irregularly but finely rugose. Sides of the thorax, also of the node, very coarsely and irregularly rugose. Anterior face of the node rugose, the dorsum and posterior faces densely reticulate-punctate, coarser than on the epinotum. Antennae, legs and gaster microscopically punctate.

Head longer than broad, much broader in front than behind, the sides and occipital border convex, the latter with a well defined margin, seen from above the sides appear to be constricted just in front of the occipital border; strongly convex longitudinally and transversely, the inferior posterior angles produced. Mandibles large, armed with five large sharp teeth. Clypeus large, the anterior border strongly convex, a rather sharp carina in the middle. Frontal area small, triangular and indistinct. Frontal carinae long, extending back almost level with the posterior margin of the eyes. Eyes large and globular, placed near the posterior third of the head. Antennae long and slender; scapes extending beyond the occipital border by almost half their length; first joint of the funiculus one and two-third times longer than the second, the second and third about equal in length, the others sub-equal. Thorax fully twice as long as broad. Pronotum one and one-half times broader than long, the anterior border and sides convex, the dorsum not margined but with a long sharp spine on each shoulder in front, the spines are directed outward and downward with the points curve inwards, they are as long as the interval between them at their base. There is a well defined constriction between the pronotum and mesonotum, the latter is as broad as long. Suture between the mesonotum and epinotum scarcely defined. Epinotum small, the dorsum merges into the declivity face by a long curve; furnished with two long sharp spines, erect, almost perpendicular, with the points bent slightly backward, almost parallel, diverging very slightly, longer and stronger than those on the pronotum. Node much longer than broad, and as broad in front as behind, the sides convex, with two sharp spines above, curved behind and outward, these spines are amost identical with those on the pronotum; in profile the node is as high as long, the dorsum convex, merging into the anterior and posterior faces, the spines sub-erect; on the ventral surface in front there is a small translucent tooth. The abdomen slightly longer than broad. Legs long and slender.

Hab.: North Queensland, Cape York (W. B. Barnard).

The only other species of this sub-genus recorded from Australia is *clotho*, Forel, from Mackay. I have not seen this species, but from the description, it is considerably smaller, the spines and the sculpture quite different. Other species of this group occur in Queensland but are not yet described.

This species has been named in honour of Mr. Barnard, who has collected a large number of ants in the extreme north of Cape York.

Polyrhachis (Myrmhopla) bicolor, Smith.

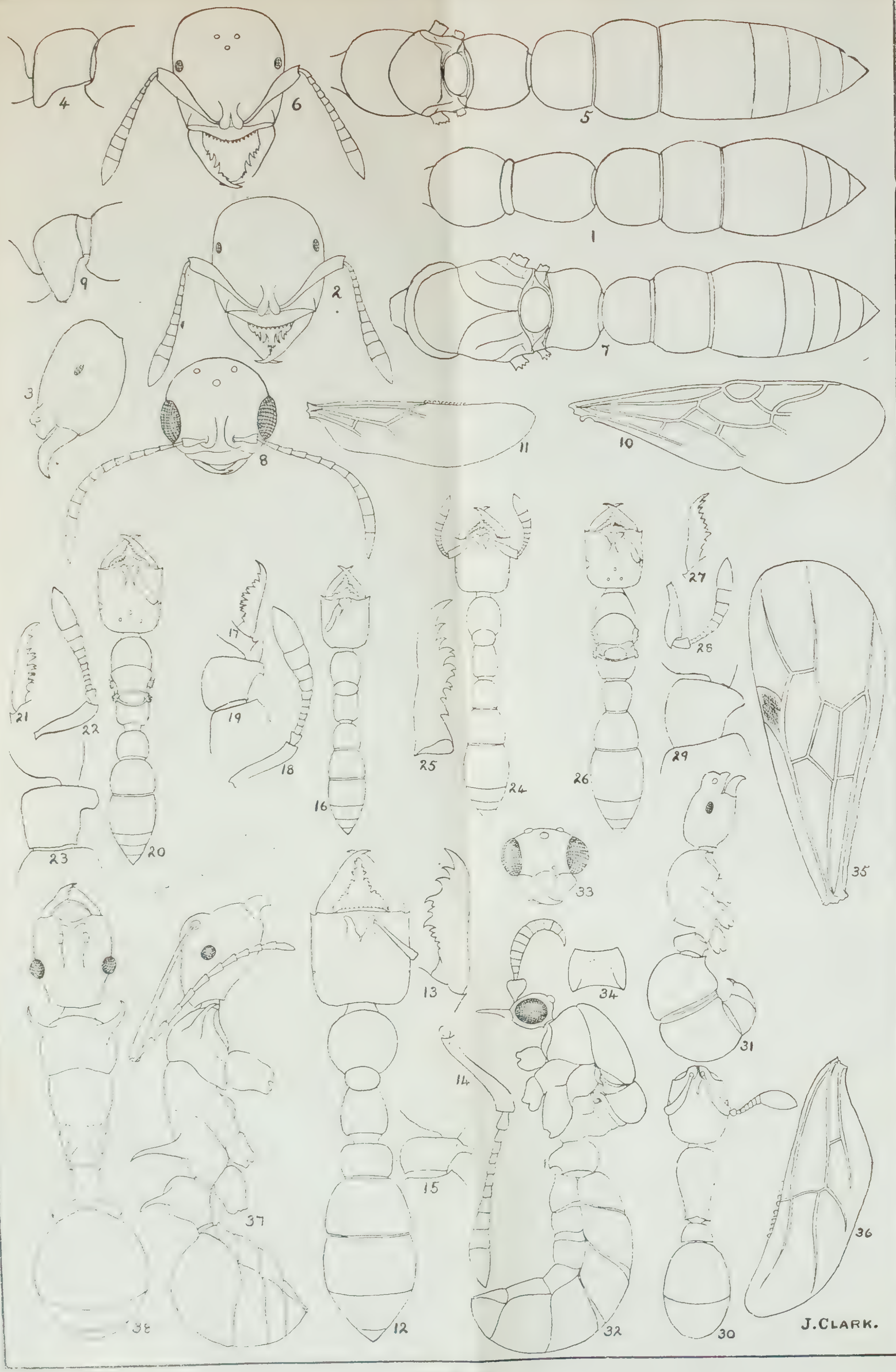
Cat. Hym. Brit. Mus. 6, p. 65, 1858.

Hab. : Darwin, Northern Territory (G. F. Hill).

A colony of this well known Indomalayan species was obtained near Darwin. The colony was found in a small, almost transparent nest amongst the leaves on a tree. It is possible that this species has been introduced.

EXPLANATION OF PLATE I.

1. Lithomyrmex glauerti, n. sp., worker, dorsal view.
2. „ „ „ „ dorsal view of head.
3. „ „ „ „ lateral view of head.
4. „ „ „ „ lateral view of node.
5. „ „ „ female, dorsal view.
6. „ „ „ „ dorsal view of head.
7. „ „ „ male, dorsal view.
8. „ „ „ „ dorsal view of head.
9. „ „ „ „ lateral view of node.
10. „ „ „ „ fore wing.
11. „ „ „ „ hind wing.
12. Amblyopone mandibularis, n. sp., worker, dorsal view.
13. „ „ „ „ mandible. . .
14. „ „ „ „ antenna.
15. „ „ „ „ lateral view of node.
16. „ wilsoni, n. sp., worker, dorsal view.
17. „ „ „ „ mandible.
18. „ „ „ „ antenna.
19. „ „ „ „ lateral view of node.
20. „ exigua, n. sp., female, dorsal view.
21. „ „ „ „ mandible.
22. „ „ „ „ antenna.
23. „ „ „ „ lateral view of node.
24. „ saundersi, Forel, worker, dorsal view.
25. „ „ „ „ mandible
26. „ „ „ female, dorsal view.
27. „ „ „ „ mandible.
28. „ „ „ „ antenna.
29. „ „ „ „ lateral view of node.
30. Discothyrea bidens, n. sp., worker, dorsal view.
31. „ „ „ „ lateral view.
32. Aenictus hilli, n. sp., male, lateral view.
33. „ „ „ „ dorsal view of head.
34. „ „ „ „ dorsal view of node.
35. „ „ „ „ fore wing.
36. „ „ „ „ hind wing.
37. Polyrhachis (Myrmhopla) barnardi, n. sp., worker, lateral view.
38. „ „ „ „ „ dorsal view.



Figures 1-38.

By Authority: Fred. Wm. Simpson, Government Printer, Perth.

5.—CONTRIBUTIONS TO THE MINERALOGY OF WESTERN AUSTRALIA.

Series iii.

(With two figures, 1 and 2.)

By

EDWARD S. SIMPSON, D.Sc., B.E., A.A.C.I.

(Read 8th May, 1928. Published 16th May, 1928.)

CONTENTS.

(1.) TANTEUXENITE (Sp. nov.), PILBARA GOLDFIELD, N.W. DIV.

Two minerals resembling euxenite in appearance have been observed on several of the tinfields of the Pilbara goldfield. One of these has now been sufficiently investigated to show that it is a new mineral species, and to enable a systematic physical and chemical description of it to be given.

Whilst normal euxenite—which has been described from Norway, Sweden, Greenland, Ontario, Brazil, Transvaal, and Madagascar—is a titanoniobate of yttrium, the mineral here described differs from it in being essentially a titanotantalate of yttrium. This substitution of tantalum for noibium is evidenced in the higher specific gravity, that for euxenite being 4.6 to 5.1, whilst for the Pilbara minerals it is 5.4 to 5.9. A new name being required for the species, Tanteuxenite is suggested. The derivation of the name is obvious.

Tanteuxenite was first detected at *Cooglegong* in some angular boulders shed from a pegmatite vein. In these it was found in masses up to 200 grammes in weight associated with grey quartz. It exhibited traces of a flattened prismatic structure, and on a fresh fracture, which was conchoidal to subconchoidal, had a brownish black colour with brilliant resinous lustre. Most of the surface, and some approximately parallel fractures, were coated with a very thin film of grey decomposition products.

In mass the Cooglegong mineral is opaque and nearly black in colour, but thin splinters are translucent up to a thickness of 0.5 mm., and transmit a pale to dark amber light according to thickness. The fine powder is of a tawny olive (17″i) colour, and under the microscope is transparent and isotropic, with an amber colour. When a fragment is heated in a closed tube it decrepitates slightly, gives off water and becomes much paler in colour, approximating that of the powdered mineral.

An analysis is given in column (1) below. A second similar specimen had a specific gravity of 5.64 with 16.1 per cent. of TiO_2. It was found to be easily broken up by fusion with potassium carbonate or potassium hydroxide, or by heating with a mixture of HF and H_2SO_4.

The mineral here described must not be confused with that from the same locality referred to by the writer as euxenite in the "Transactions of the Australasian Association" for 1907 (Vol. XI., p. 446). This mineral, which is the second one referred to in the first paragraph above, apparently occurs also at Leeds tin find on Abydos Station. It is somewhat different in appearance, and contains much more titanium oxide than tanteuxenite, and is being further investigated. It is probably the tantalum mineral corresponding to polycrase or blomstrandine, according to the latest convention.

From a pegmatite in granite a few miles S.E. of Cunmagnunna Trig. (B4) on *Woodstock Station*, a few pounds of less typical tanteuxenite have been obtained. During a brief inspection the writer could find no more beyond the small pocket originally discovered in 1926. The mineral from this place is similar in appearance to that from Cooglegong. It has a hardness of 5.5 to 6.0, is devoid of crystalline form or cleavage, has a subconchoidal fracture, is brownish black in colour, and opaque in mass, with a resinous lustre. The powder is tawny olive in colour, and under the microscope transparent, brownish amber, and isotropic.

Titanium determinations on various fragments gave from 20 to 21 per cent. of TiO_2, the specific gravity ranging from 5.5 to 5.6. Two complete analyses were made, and are given in columns (2) and (3) below. The mean figures indicate a much smaller excess of tantalum over niobium than is the case with the Cooglegong mineral. The definite detection of bismuth in the mineral is of interest, as it has never previously been observed in a mineral of this type. Failure to recognise it and separate it from the associated lead in such minerals would vitiate any calculation regarding their age. The geological age calculated from the Woodstock mineral is excessive, and it is evident that either lead has been added to the mineral, or uranium leached out by weathering, or, like the plumboniobite of East Africa, it contains primary lead.

Tanteuxenite, Cooglegong and Woodstock.

	Cooglegong.	Woodstock. A.	Woodstock, B.
	%	%	%
Ta_2O_5	47.31	22.95	24.84
Nb_2O_5	3.83	15.27	13.40
TiO_2	14.17	21.05	20.71
SnO_2	.14	.44	.42
ThO_2	trace	2.86	3.16
$Y_2O_3.Er_2O_3$	17.48	16.36*	16.62†
Ce_2O_3	7.22	9.40	9.04
$La_2O_3.Di_2O_3$		.14	.34
UO_3	3.35	4.16	4.04
PbO	traces	1.71	1.64
Fe_2O_3	1.18	1.53	1.48
MnO	.35	.28	.28
CaO	2.22	.97	.97
Al_2O_3	*Nil*	.31	.61
Bi_2O_3	*Nil*	.04	.04
SiO_2	.90	.13	.56
Na_2O	trace	*Nil*	*Nil*
Ign.	2.40	2.24	2.16
Total	100.55	99.84	100.31
Sp. Gr. ...	5.77	5.55	5.55
Analyst ...	E.S.S.	D. G. Murray	D.G.M.

* Approx. Y_2O_3, 11.32 ; Er_2O_3, 5.04.
† Approx. Y_2O_3, 11.50 ; Er_2O_3, 5.12.

Assuming that the UO_3 represents weathered UO_2, and that this and the ThO_2 are isomorphous with the TiO_2, the mean figures for the two Woodstock analyses give approximately the formula—

$$3Y_2O_3.\ CaO.\ 9TiO_2.\ 4Ta_2O_5.$$

which is equivalent to an isomorphous cocrystallisation of—

$$4YTi_2TaO_8 + Y_2Ta_2O_8 + CaTiTa_2O_8$$

from which the essential constituent of tanteuxenite is considered to be YTi_2TaO_8; and of euxenite, YTi_2NbO_8. Expanded, these formulae are of the form $Y_2O_3.4TiO_2.Ta_2O_5$.

Two other localities in the North-West division have yielded specimens of a mineral not yet analysed, but assumed to be tanteuxenite on account of their chemical and physical properties. They are Eleys, 10 miles S. of Cooglegong, and 40 miles E.N.E. of the Woodstock find, and Mt. Francisco, 30 miles N.W. of Woodstock.

At *Eleys* the mineral is plentiful in alluvial tin rejects from Mineral Claim 15, forming 27 per cent. of a parcel of rejects collected by the writer in 1927. It is in subangular to well rounded pebbles, ranging in weight from 0.5 to 4 grammes. On the exposed surface it is brown or brownish back in colour with dull lustre, but fresh fractures reveal the typical resinous lustre and normal appearance both in mass and under the microscope. A series of specific gravities determined were 5.61, 5.58, 5.56, 5.54, 5.50, 5.36. The pebble with a gravity of 5.58 had 18.07 per cent. of TiO_2.

Several specimens from Eleys are distinctly tabular in structure, and almost certainly orthorhombic, though they are too water-worn to be capable of angular measurement. The commonest forms appear to be (100), (010) and (001). What appear to be the prism faces are vertically striated.

On a tin lease six miles S.E. of the Government well at *Mt. Francisco*, the writer found water-worn pebbles of tanteuxenite not uncommon in alluvial tin concentrates. The pebbles collected never had a greater mass than 2 grammes, and were coated with a strongly adherent reddish brown decomposition product with a dull lustre. After removing part of this coating by dipping in and out of hydrofluoric acid, specific gravities of 5.42, 5.59, 5.71, 5.78, and 5.90 were obtained. The pebble with a gravity of 5.78 contained 18.16 per cent. of TiO_2. On a fresh fracture the mineral had the typical appearance of tanteuxenite and indistinct indications of tabular crystallisation were again apparent.

A systematic description of the mineral is as follows:—*Tanteuxenite*: Essential composition, a titanotantalate of yttrium, YTi_2TaO_7; ($Y_2O_3 4TiO_2$, Ta_2O_5), a minor part of the tantalum being replaceable by niobium. Other isomorphous replacements of the whole molecule are probably $CaTiTa_2O_7$ and $Y_2Ta_2O_8$, whilst Th and U may partly replace Ti, and Er, Ce, etc., partly replace Y. Orthorhombic; habit tabular parallel to the macropinacoid. Cleavage, none; fracture, conchoidal to subconchoidal. Hardness, 5 to 6; brittle. G, 5.4 to 5.9, the variation mainly due to varying proportions of tantalum and niobium. Colour in mass brownish black to dark brown (seal brown, 5″m); apparently opaque, but translucent at about 0.5mm. Powder greyish yellow (typically tawny olive, 17″i), transparent and brownish yellow under the microscope, and abnormally isotropic owing to hydration. Before the blowpipe, infusible, glows not at all or only very slightly, sometimes decrepitates, always yields water, and coarse fragments pale to about the colour of the powdered mineral. Slowly attacked by hot strong hydrochloric or sulphuric acid, but most readily dissolved by a mixture of hydrofluoric and sulphuric acids, or by fusion with potassium carbonate or potassium hydroxide and treatment of the fused mass with hydrochloric acid. The type mineral is that from Cooglegong.

(2) MICROLITE, STRELLEY, N.W. DIV.

The first record of microlite in Australia was that made by the writer in 1907 of this mineral at Green's Well near Wodgina*. In 1917 the writer described tapiolite from Strelley, then known as Tabba Tabba North. The latter deposit is now being reworked and in parcels of ore from 2½ miles north of M.L. 321, there has been detected an occasional intergrowth of tapiolite and microlite.

The mixture is in coarse detrital pebbles weighing up to 100 grammes. In one case only were any crystal faces observed and these appeared to indicate that the whole mass had the form of a complex twin of tapiolite. The other pebbles are well water worn. The major part of each pebble consists of a black iron tantalate, apparently tapiolite. Irregular portions of the surface are composed, however, of a second opaque mineral of a pale buff to

* A.A.A.S. 1907, p. 451, also A.A.A.S. 1909, p. 314.

cinnamon colour, and on fracturing the specimens, these areas are found to penetrate to varying depths, forming ragged boundaries with the tapiolite and often penetrating deeply into it in minute veins. This structure, in conjunction with the one crystal observed, suggests that the pale mineral is a replacement of the tapiolite.

For detailed examination a pebble weighing 85 grammes and having a density of 6.51 was chosen. It was split into four pieces having densities of 6.85, 6.50, 6.50, and 6.20. The lightest piece showed the greatest proportion of the pale coloured mineral. It was crushed and analysed with the following results:—

Intergrowth of Microlite and Tapiolite, Strelley.

Ta_2O_5	Nb_2O_5	TiO_2	SnO_2	SiO_2	CaO	MgO	MnO	FeO	Fe_2O_3
77.96	.96	.30	.40	1.76	7.12	*Nil*	.60	2.88	1.78

Al_2O_3	Na_2O	K_2O	F	H_2O+	H_2O-	Total	Less O	F
·24	3·68	·15	2·04	·40	·09	100·36	0·68	

For the careful analysis made the writer is indebted to Mr. D. G. Murray of the Government Laboratory.

The analysis confirms the light coloured mineral as being a fluotantalate of lime and soda, without doubt microlite. Examination of the analysed powder under the microscope indicated a relative volume of three parts of black opaque tapiolite to 10 parts of transparent, almost colourless, isotropic, microlite. Associated with them were a few small grains of quartz, albite and limonite.

Microlite is usually described as being a pyro-tantalate with two molecules of lime to one of tantalic oxide, a commonly accepted formula being $3Ca_2Ta_2O_7.NaF$. The most satisfactory analysis of the mineral hitherto published, that of the Virginian mineral, does not however bear this out, but indicates rather a metatantalate, corresponding approximately to $CaTa_2O_6.NaF$ or $3CaTa_2O_6.2NaF$.

The analysis of the Strelley mixture gives a ratio for all protoxides to all tantalic and niobic oxides of one to one. Since the tapiolite portion of the mixture is known to have this ratio it follows that the residue must have the same ratio, that is, that the Strelley microlite is a metatantalate. Assuming the formula $CaTa_2O_6.NaF$ for it, the analysis agrees almost exactly with the following mineral composition:—

	per cent.
Microlite	68.8
Tapiolite	27.3
Limonite	1.6
Albite	1.1
Quartz	1.0
Water	.2
	100.0

Such a mixture would have by calculation a density of 6.1 against the observed density of 6.2. It would also have a volume ratio of tapiolite to microlite of 10 to 3, a ratio confirmed by several counts under the microscope of the analysed powder.

(3) ANDALUSITE, TOODYAY, S.W. DIV.

We are indebted to Mr. J. E. Wells, a member of this Society, for several important discoveries in the Toodyay district, the latest of which is that of andalusite at two points in Jimperding Valley, about six miles S.W. of the Toodyay railway station. Both places are in a belt of mica schists running approximately N.W. through the valley.

The first find was on a cultivated field, about one mile S.S.W. of Kowal-you-Katta Hill. Whilst the mica schists were half a mile wide, the andalusite was confined to some low hills occupying a few acres only, lying between, and possibly genetically connected with, two parallel epidorite dykes. Loose crystals of andalusite were lying in profusion over the soil, and the rock outcrops were thickly studded with them. It was not unusual to find between five and ten per cent. of the exposed area of the schist consisting of projecting crystals. The crystals vary in size from 10 x 5 x 5 to 40 x 40 x 40 or 60 x 20 x 20 millimetres. Their form is that of a fairly sharply outlined prism (110) with imperfectly defined terminations. The ends taper off indefinitely, or are terminated at each end by single faces approximating to (011) and (0 1 1). Rarely the termination is roughly at right angles to the prism. The crystals weather out, or break out, of the schist with very little adherent mica.

Fig. 1. Chiastolite Crystals, Toodyay. Scale: natural.

The bracketed cross-sections represent opposite ends of one crystal. The vertical section indicates a black centred cross at the middle with a hollow white square at either end.

In this occurrence the crystals are dark grey in colour owing to inclusion of carbon dust, and many of the larger ones exhibit typical chiastolitic structure when cross sectioned. One such exhibited a hollow white square at one end, passing into a central cross at the other, like the crystal figured by Dana in his System.* Many others show white cruciform figures, often with black centres at the intersections, whose limbs make angles ranging from 60° to 90° with one another. Two crystals split parallel to (110) showed an hour-glass arrangement of the carbonaceous inclusions. (See Fig. 1.)

* System of Mineralogy, VII., 497.

About 1½ miles to the S.S.E., on the same belt of schist, a second andalusite bearing zone has been discovered. The crystals here are of similar size and approximately similar form to those at the first place. They are, however, much less heavily charged with carbon, and so far as yet observed, have not any geometrical arrangement of the inclusions. A distinct feature of this occurrence is the invariable outer coat of mica 2 to 5 mm. thick on each crystal. This mica is in fairly coarse plates arranged at right angles to the adjacent andalusite face, and the coating preserves externally, in a roughened form the shape of the enclosed crystal. The junction between the mica and the andalusite is at times a sharply defined face of the latter, at times quite ragged. This mica, in its orientation relative to the andalusite crystals, is quite distinct from that of the schist, and adheres persistently to the crystals which weather out from the rock. It is plainly an alteration product of the andalusite such as has been recorded in several localities by Hintze and Lacroix.

(4) GROSSULARITE, MT. FRANCISO, N.W. DIV.

Up till recently 76 mineral species had been detected within a 20-mile radius of Mt. Tinstone in the Wodgina massif. Grossularite, which has now been found close to the Government Well at Mt. Francisco, brings the total of species up to 77.

The mineral is in large uncrystallised masses with small inclusions of epidote. Its matrix is unknown. The garnet in colour ranges from about Ridgway's 11″b (onion skin pink) to 9″k (walnut brown), the paler tints prevailing. It is translucent in a thickness of 2mm. An analysis of a typical light-coloured fragment gave:—

SiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	H_2O-	Total.
38.50	18.94	4.90	1.52	.23	.49	35.08	.32	99.98

The specific gravity is 3.65.

The percentage proportions of the pure isomorphous molecules calculated from the analysis are:—

Grossularite	81.0
Andradite	13.7
Almandine	3.2
Pyrope	1.9
Spessartite	.2
	100.0

(5) SPESSARTITE, TABBA AND STANNUM, N.W. DIV.

Detrital tantalite concentrates obtained by the writer from the surface soil of Thelemann's M.L. 317, at Tabba, contained a large number of small (2 to 3 mm.) loose crystals of spessartite. They all have the same form, viz., the trapezohedron (211) with more or less distinct traces of the dodecahedron (110). In colour they range from Ridgways 13″ (orange cinnamon) to 13″d (light vinaceous cinnamon). They are translucent in a thickness of about 2 mm., and isotropic.

An analysis given in column (1) below shows the mineral is a fairly typical spessartite, with 85 per cent. of pure spessartite molecules and 15

per cent. of almandine. In view of Dana's description of the colour of spessartite, viz., "dark hyacinth red, sometimes with a tinge of violet, to brownish red." the pale colour of this, and the previously described Wodgina spessartite,* is noteworthy. It is to be observed, however, that Hintze (II-B der Min. II., 67) says of spessartite that "the purest varieties have a yellow colour"; and Lacroix (Min. de Fr. I., 255) says "colour, light yellowish brown, brownish red more or less dark." The mineral is doubtless derived from one of the adjacent tantalite-bearing pegmatites.

A garnet collected near the old tin workings at Stannum is very different in appearance. The detrital specimens received are distinctly crystallised in trapezohedra (211) reaching to 5 cm. in diameter, the larger ones often enclosing much quartz towards the centre. The colour in mass varies from 7"k (cameo brown) to almost black, the lighter ones being translucent in thicknesses of about 1mm., and isotropic.

An analysis was made of one of the darker specimens with the results given below in column (2). The molecular ratios do not agree closely with those established for garnet unless we assume that all the iron was originally in the ferrous condition, weathering having oxidised some of it to ferric oxide. On this quite justifiable assumption the molecular composition of the garnet, in terms of the pure molecules is spessartite, 50.5; almandine, 49.1; pyrope, 0.2; grossularite, 02. A second specimen had a specific gravity of 4.21 with 12.8 per cent. of ferrous oxide, indicating a smaller proportion of the almandine molecule.

		Tabba.	Stannum.
SiO_2	... ...	36.79	35.77
Al_2O_3	... ...	20.40	20.38
Fe_2O_3	... ...	.46	3.00
FeO	... ...	6.71	18.83
MnO	... ...	35.87	21.84
MgO	... ...	*Nil*	.06
CaO	... ...	*Nil*	.06
H_2O +	... ...	.16	.16
	Total	100.43	100.18
	Sp. Gr. ...	4.18	4.24
	Analyst	J. N. A. Grace.	C. R. Le Mesurier

(6.) ANDRADITE, MELVILLE AND WEELHAMBY LAKE.

Large masses of garnet occur in the Archaean greenstone forming the walls of a gold bearing vein on Harrison's Lease No 27, at Melville (Murchison Division). These masses are intergrowths of a number of individual crystals which by mutual interference have only been allowed to develop a few imperfect trapezohedral faces. The mineral is dark brown in colour (about Ridgway 8 m.) and is only translucent in thin splinters, about 0.5 mm. Some small inclusions of quartz can be seen in the masses.

* J.R.S.W.A., XIII. (1927), 41.

An analysis was made of some of the cleanest mineral with the results given below. They indicate the presence of about 5.28 per cent. of included quartz; after deducting this the ratios RO: R_2O_3: SiO_2 become 2.995: 1.001: 2.997. The remaining garnet is a typical andradite with the following proportions of the pure molecules:

Andradite	95.4
Fe″ Fe‴ garnet ...	3.4
Almandine	.7
Spessartite	.5
	100.0

Specimens of andradite in masses up to a kilogramme in weight have been collected on the surface at Weelhamby Lake, 15 miles N.E. of Bowgada (S.W. Division). They are devoid of crystal faces and less vitreous and darker in colour than the Melville mineral, being about Ridgway's 11‴ m. Even the cleanest mineral selected for analysis was contaminated with a few minute grains of epidote, actinolite and quartz. The results of analysing this slightly impure mineral are given in column (3) below, from which the calculated ratios RO: R_2O_3: SiO are 3.00: 0.95: 3.17. The calculated molecular percentages show a large cocrystallisation of the grossularite molecule, the figures being:—

Andradite	57
Grossularite	34
Almandine	4
Spessartite	4
Pyrope	1
	100

The analytical figures are:—

	(1.)	(2.)	(3.)
SiO_2	38.79	35.37	38.40
TiO_2	.01	.01	.41
Al_2O_3	.22	.23	8.27
Fe_2O_3	29.38	31.01	17.90
FeO	1.61	1.70	1.76
MnO	.20	.21	1.38
MgO	.01	.01	.29
CaO	29.85	31.51	31.21
H_2O	.13	.14	.32
	100.20	100.19	99.94
G.	3.87	3.97	3.59

Analyst, C. R. LeMesurier.

(1.) Andradite contaminated with quartz, Melville.
(2.) The same calculated after deducting 5·28 per cent. quartz.
(3.) Andradite slightly contaminated with epidote, quartz, and actinolite, Weelhamby Lak

(7.) SPODUMENE, WODGINA, N.W. DIV.

In the spring of 1927 the writer found spodumene to be plentiful in boulders of pegmatite on one of the dumps of the Mt. Cassiterite Tin Mine. The mineral is in flat cleavable masses from 5 x 3 x 2 mm. up to 50 x 25 x 5 mm. The only faces seen are a(100), b(010), and m(110): the terminations of the prisms are indefinite. The colour in mass is "pallid neutral grey" or "pale olive grey" to "olive buff." An analysis by Mr. H. P. Rowledge gave the following figures:

SiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO
64.17	28.08	.12	.21	.18	.11	*Nil*
Li_2O	Na_2O	K_2O	TiO_2	H_2O	Total	G.
6.70	.37	.22	.03	.30	100.49	3.17

(8.) CUMMINGTONITE, WARRIEDAR, S.W. DIV.

In his Bulletin dealing with the gold mines at Warriedar* F. R. Feldtmann refers in several places to the occurrence of "asbestos" in the mines. This mineral was a source of difficulty in the batteries, where it caused from time to time a clogging of the screens.

In 1923 the writer collected specimens of this mineral at the Mug's Luck gold mine, where it was found to fill discontinuous veins and form confused masses in a slightly shattered, microscopically fibrous amphibolite. The fibres range from 2 to 10 mm. in length, are very fine in staple, and somewhat brittle. The least altered mineral is "mineral grey" (Ridgway 25″″d) in colour, but the ferrous iron in it is prone to oxidise, and the collected specimens, which came from ground-water level, exhibit all stages of alteration with corresponding ranges of colour from grey to "cinnamon" (15″).

Some of the grey, apparently unaltered, mineral with a specific gravity of 3.28 was selected for analysis and gave the following results: —

SiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO
56.74	.91	3.14	24.41	1.58	9.72	.42
Na_2O	K_2O	H_2O+	H_2O-	Total		
Nil	*Nil*	3.03	.78	100.73		

Analyst: H. P. Rowledge.

The analysis indicates a ferro-anthophyllite or cummingtonite.

Examination of the fibres under the microscope reveals the fact that whilst the majority of them give a straight extinction, some exhibit an extinction angle up to 15deg. This suggests that the mineral is the monoclinic cummingtonite (recorded extinction angle, 17deg.), rather than the orthorhombic anthophyllite. Both minerals belong to the amphibole group and have at times an asbestiform structure.

This is the first record of cummingtonite in the State.

(9) CORUNDUM, ABYDOS, BURBANKS AND BALBARRUP.

Five miles north of the homestead on Abydos Station (N.W. Div.) in gently undulating granite country traversed by numerous pegmatite veins, there is a band of chlorite-biotite schist about 8 feet wide, which carries corundum. This rock can be traced for several chains through the granite and passes into a hornblende felspar gneiss. Several pounds of detrital and

* Geol. Surv., W.A. Bull. 81, (1921).

usually fractured crystals, were picked up in a short time by the writer and a few specimens were seen embedded in the schist, from which subsequently about 3 cwt. of mineral was obtained in digging to a depth of 6 feet.

The crystals vary in size from 3 x 1 cm. to broken fragments having a diameter of 5 cm. They are distinctly, and sometimes sharply, hexagonal in basal section, and taper roughly towards each end, the actual pyramids present, in addition to the unit prism, being indeterminate. An imperfect basal parting is present, which discloses a multiple zoning clearly and sharply defined in concentric hexagons of slightly varying shades of the main colours, the powder from a single crystal varying from pale blue to lilac. In mass the colours of different crystals range from Ridgways 57′m (dusky blue violet) through 59″ (hyssop violet) to 65″b (argyle purple). A narrow dull green (37′i) outermost zone is noticed on some crystals. The surface is coated with strongly adherent mica. The twinning plane r (10-11) is strongly marked, with striations of r^2 and r^6 plainly visible. The measured angle r^1 r^2 was 94°. A density of 3.94 was noted.

About two miles west of the townsite of Burbanks (Cen. Div.) is an outcrop of brilliant green fuchsite schist in which strings and globular aggregates of a finely granular red mineral can be seen. By crushing and panning the rock this mineral can be collected in the form of a heavy concentrate which is Indian lake (71′i) in colour when wet, but slightly paler when dry, viz., about magenta (67′).

Under the microscope the mineral is seen to be corundum crystallised in hexagonal bipyramids and prisms, the common forms being z (22 41), c (0001) and a (11-20) in the combinations zc, aze or ac. A basal cleavage is seen in most of the crystals and a rhombohedral parting in several. The largest crystal is 1 mm. long and 0.2 mm. in diameter. The density is 4.01. All are transparent and strongly pleochroic, O being hyssop violet (Ridgway 59″, and E, very pale yellow.

The colour and transparency of the Burbanks mineral bring it within the definition of ruby, but so far no crystal has been discovered large enough to be cut into a gem.

Besides fuchsite the accompanying minerals are brown andalusite, which is plentiful, and small crystals of blue kyanite, which are rare.

A gravelly alluvial concentrate from Balbarrup (S.W. Div.) on examination proved to be a mixture of rutile, kyanite and dull yellowish corundum. The latter was in rounded, often corroded, pebbles from 2 to 5 mm. in diameter exhibiting occasionally a rhombohedral parting. The corroded fragments had some white clay adherent to them. The composition of some of the cleanest fragments was:-

Al_2O_3	Fe_2O_3	MgO	SiO_2	TiO_2	H_2O	Total	G.
83.84	3.70	trace	9.04	1.98	1.44	100.00	3.88

No. CaO, ZrO_2, rare earths, P_2O_5, or Ta_2O_5 could be detected in it.

In mass the mineral is opaque with dull to waxy, or very rarely brilliant, lustre. Under the microscope the powder is colourless with films of yellow limonite: and many rhombohedral parting plates are seen with angles of 93deg. and 87deg., diagonal extinction, and low birefringence.

(10.) OCTAHEDRITE, KUNJIN, S.W. DIV.

When making a mechanical analysis of a pure white, very fine grained pottery clay, probably a kaolinised epidiorite, from Kunjin, a small percentage (0.05 per cent.) of heavy concentrate was obtained. The constituents of this all had densities over 3.3 (methylene iodide), the most abundant of them being zircon.

About one-fifth of the concentrate was typical octahedrite in flat crystals, probably cleavage plates, parallel to (001). The outlines of some typical individuals, drawn to scale, are shown in the accompanying figure (Fig. 2). The combination most commonly observed was $c^1 c_1$

Fig. 2.—Octahedrite, Kunjin. Scale: 1 : 200.

p^1 p^2 p^3 p^4 p_1 p_2 p_3 p_4*, with occasionally one or more small faces of the form a (100). Very few of the grains were bounded completely by crystal faces, ragged outlines replacing them in part. The diameter varied from 0.03 to 0.20 mm., the thickness from 0.01 to 0.05 mm.

Most of the crystals were perfectly transparent, but some were slightly clouded from the presence of minute inclusions. The greater number were colourless, but some were tinged with brown, others with dull blue or green. One was seen to have a green periphery with brown centre. A good uniaxial figure was obtained, and the sign of the birefringence proved to be negative.

The only other record of octahedrite in the State is at Mt. Monger (E. S. Simpson, G.S.W.A. Bull. 90, p. 23).

*C. (001), p. (111).

By Authority: FRED. WM. SIMPSON, Government Printer, Perth.

6. FURTHER CONTRIBUTIONS TO THE HELMINTHS OF WESTERN AUSTRALIAN STOCK.

By

H. W. Bennetts, B.V.Sc., Veterinary Pathologist.
Department of Agriculture.

Series II.

(Read 8th May, 1928. Published 16th May, 1928.)

In a recent publication (1) the writer gave a list of species of helminths known to affect stock in this State. Since then the following additional species have been diagnosed:

A. CESTODES.

1. *Davainea echinobothridia* (Megnin, 1880), Blanchard, 1891.

Two specimens, presenting no unusual features other than that the genital pores were almost entirely unilateral (usually irregularly alternate).

Host. Fowl: intestine.

Locality. Northam, 23 / 7 / 27.

Remarks. Apparently not previously recorded in Australia.

2. *Anoplocephala perfoliata* (Goeze, 1782).

Host. Horse: caecum.

Locality. Perth Zoo, 11 & 27

Remarks. Though, apparently, not an uncommon parasite of horses, there is no previous record of this species for W.A. Associated with this species were: *Strongylus spp.*, *Trichonema pocalatum*, *Trichonema sp.*, and *Gyalocephalus sp.*

B. NEMATODES.

1. *Triodontophorus brevicauda* (Boulenger, 1916).

Four specimens, two males and two females presenting no unusual features all characters agree with those given in the original description of the species (2).

Host.- Horse: intestine.

Locality. -Fitzroy Crossing (Kimberley), 26 / 7 / 27.

Remarks.—These specimens, along with other species of Nematodes were submitted by Murnane from a case of "Kimberley Horse Disease. This species has not been previously recorded in Australia.

u 12527 28.

2. *Triodontophorus minor* (Looss, 1900).

Four specimens, one male and three females. The characters exhibited by the specimens were identical with those given by Looss for this species, except that in all cases the anterior margins of the teeth were more or less deeply serrated. Boulenger (3), however, states that this feature is found in some individuals of the species.

Host. As previous species.

Locality.—As previous species.

Remarks.—This species has not previously been recorded in Australia.

3. *Trichonema poculatum* (Looss, 1900).

Four specimens, one male and three females, presenting no special features.

Host.—Horse: caecum.

Locality.—Perth Zoo, 11/8/27.

Remarks.—Large numbers of *Trichonema spp.* were present in Caecum and Colon. The mucous membrane of the Caecum was pitted with small ulcers, some of which were haemorrhagic.

4. *Gyalocephalus sp.*

Only one specimen, female, was obtained. No specific identification was attempted.

Host. As previous species.

Locality. —As previous species.

Remarks.—This genus has, apparently, not been recorded in Australia.

5. *Oesophagostomum venulosum* (Rud., 1809).

Three adult females, presenting no special features.

Host.—Sheep: colon.

Locality.—Broome Hill, 13/10/27.

Remarks. —Present in association with *Chabertia ovina.* Apparently this species has not previously been recorded in Australia.

6. *Onchocerca cervicalis* (Railliet & Henry, 1910).

Reference has been made previously to a species of Onchocerca commonly found in cases of fistulous withers in this State (1). Messrs. Weston and Le Souef kindly supplied the material from which specimens, to be described, were obtained. The material consisted of pathological tissue from an acute case of fistulous withers. The sinuses contained a serous type of pus in which were enormous numbers of worms, their extremities however being firmly embedded in the surrounding fibrous tissue. A portion of necrotic ligamentum nuchae also contained very numerous parasites.

No complete specimens were obtained (Railliet and Henry (4) described the species from incomplete worms). Portions including the anterior extremities of six females and posterior extremities of one female and two males, were examined.

Male. Length undetermined, maximum diameter 160 microns: Railliet and Henry give 200 microns for this. The length of the oesophagus was not determined. Railliet and Henry give the following formula for caudal papillae: Preanal 1; Paranal 4; Postanal two groups—two situated approximately midway between cloaca and point of tail (two) near caudal extremity. This arrangement was found in both specimens examined, though the first group of postanal papillae was very indefinite.

The lengths of the spicules were respectively approximately 370 microns and 110 microns (both specimens) quite in accord with the corresponding measurements given by Railliet and Henry.

Female.- Total length undetermined. Maximum breadth 350 microns—Railliet and Henry give 400 microns. There is one cuticular thickening to each three or four transverse striations. The length of the oesophagus in six specimens varied from 2.2 mm. to 2.3 mm.—Railliet and Henry give 2.4 mm.

The distance between the opening of the vulva and mouth varied from 550 to 600 microns—Railliet and Henry give 375 to 410 microns.

The only notable point of difference between the local specimens and *Onchocerca cervicalis*, as described by Railliet and Henry, is that the vulva opening is situated somewhat more posteriorly in the former. However, I think a definite diagnosis of *O. cervicalis* for the local species is warranted.

Host. Horse: fistulous wither in ligamentum nuchae, sinuses, and inflammatory fibrous tissue.

Remarks.—Not previously recorded, as such, in Australia.

BIBLIOGRAPHY.

(1) **Bennetts**—"The Helminths of W.A. Stock." Series I. Proc. Royal Society, W.A., XIII., 1926-27, pp. 49-60.

(2) **Boulenger**—"Sclerostome Parasites of the Horse in England." Parasitology VIII., 1915-16, pp. 430-432.

(3) **Boulenger**—"Strongylid Parasites of Horses in Punjab." Ibid. XIII., 1921, p. 317.

(4) **Railliet and Henry** "Les Onchocerques Nematodes Parasites du Tissu Conjunctif." Compt. Rend. des Seances de la Soc. Biol. LXVIII., 1910, p. 249.

By Authority: F. R. Wm. Simpson, Government Printer, Perth.

7.—THE VERTEBRATE FAUNA OF WESTERN AUSTRALIA.

By

L. GLAUERT, B.A., F.G.S., Curator of the W.A. Museum.*

(Read 8th May, 1928; Published 21st May, 1928.)

Part 1.—REPTILIA.

Section (a)- Tortoises, Turtles, Crocodiles, Snakes.

The first published list of Western Australian vertebrates appeared in the Western Australian Year Book for 1898-99 of 1900, where the late Curator of the Museum, Bernard H. Woodward, F.C.S., gave lists of the Mammals and Birds and brief notes on some of the Reptiles. In the next issue for 1900-01 the faunal list was extended to include Reptiles and Amphibia, the Mammals were revised and a few names added to the Birds. This Year Book also contained the first attempt to list the marine and freshwater fish of the State, with the localities where they had been collected.

Lists dealing with larger or smaller groups of vertebrates appear in the various volumes of Michaelsen and Hartmeyer's "Fauna Sudwest Australiens" whilst brief notes, which are sometimes rather misleading, have been published in the "Handbook and Guide to Western Australia," prepared for the visit of the British Association for the Advancement of Science in 1914, and in "Science in Western Australia," the handbook presented to members of the Australasian Association for the Advancement of Science at the Perth Meeting, 1926.

The present paper is based primarily upon the collections in the Western Australian Museum, but ample use has been made of other sources where the evidence has been considered to be quite satisfactory. The aim has been to make the list as reliable as possible, and therefore the right of every species to be included in the Western Australian Fauna has been most carefully examined. As a result some names which have appeared in previous lists are excluded, although it is not thereby suggested that the form will not eventually be found to occur within the confines of the State.

As Professor Nicholls has not yet completed his work on the Amphibia of Western Australia, it has been thought advisable to omit all reference to this class for the present.

It is hoped that the keys now included for the first time will be an assistance to local naturalists.

REPTILIA.

Order: TESTUDINATA.

Turtles and Tortoises.

Turtles and tortoises are represented in Western Australia and the adjacent seas by species belonging to three families, the *Cheloniidae*, the *Dermochelidae*, and the *Chelydidae*. Of these, the two first are marine, and the third family freshwater forms. Our leathery turtle, *Dermochelys coriacea*,

* By permission of the Trustees.

sometimes known as the Luth, is easily distinguished by the skin which covers both the carapace and the plastron. Keys are provided for the separation of the species belonging to the other genera.

Family: DERMOCHELIDAE.

Dermochelys coriacea (Linne), Syst. Nat. XII., ed. 1766, p. 350. Kimberley, Shark Bay, Rottnest, Geographe Bay.

Family: CHELONIIDAE.

Chelonia mydas (Linne), Syst. Nat. XII., ed. 1766, p. 350. Kimberley, Lacepede Islands, Shark Bay. Fremantle (young).

Chelonia imbricata (Linne), Syst. Nat. XII., ed. 1766, p. 350. Kimberley, Shark Bay. Fremantle (young).

Chelonia depressa Garman, Bull. Mus.-Comp. Zool., Harvard VI., 1881. p. 124. Kimberley.

Caretta caretta (Linne), Syst. Nat. XII., ed. 1766, p. 351. Kimberley, Shark Bay, Rottnest.

Key to Species.

A.—Costal shields in 5 or more pairs .... *Caretta caretta.*

B.—Costal shields in 4 pairs—genus .... *Chelonia.*

A1.—Jaws hooked, 2 pairs of prefrontals .... *imbricata.*

B1.—Jaws not hooked, a single pair of prefrontals.

A2.—Three post oculars, Carapace bow-shaped in section, limbs mainly covered with wrinkled skin .... *depressa.*

B2.—Four or five post oculars, Carapace tectiform in section, limbs mainly covered with hard plates .... *mydas.*

Family: CHELYDIDAE.

This family, which contains about 30 species, is confined to the Australian Region and South America. Two genera *Chelodina* and *Emydura* are known to occur in Western Australia, whilst it is possible that a third, *Elseya*, will be added to the list when more attention has been paid to the fauna of the Kimberley District, which zoologically is still to a great extent a terra incognita.

Chelodina is represented by two species, *Ch. oblonga*, which seems to be confined to the southern part of the State, and *Ch. steindachneri* which ranges, as far as we know at present, from the De Grey in the north to the Murchison in the south; inland it has been met with as far east as Lake Violet. *Emydura* is less widely distributed, the single local species, *E. maquarrii*, is known from the valley of the Fitzroy only, and does not extend beyond the Kimberley district in this State.

Chelodina oblonga, Gray, in Grey's "Journal of Two Expeditions during the years 1837, 38, and 39," II. 1841, p. 446, pl. VII., Southern Western Australia from Moore River to Pallinup River.

Chelodina steindachneri, Siebenrock Anz. K. Akad. Wiss Wien. (Mathnaturw.), Anz. XVIII., 1914, p 1*. North-Western Western Australia from De Grey River to Murchison River.

Emydura macquarrii (Gray), Syn. Northern Western Australia, Fitzroy River.

Key to the Species.

A.—Neck shorter than the dorsal vertebral column, first vertebral shield not larger than the second .... *Emydura macquarrii.*

B.—Neck longer than the dorsal vertebral column, first vertebral shield longer than the second.

A1.—Intergular not twice as long as the suture between the pectorals, neck longer .... *Chelodina oblonga.*

B1.—Intergular more than twice as long as the suture between the pectorals, neck shorter .... *Chelodina steindachneri.*

* *C. milly-millyensis* Glauert Journ. & Proc. R. Soc. W.A., IX. Part 1—1923, p. 53, pl. IV., V.

Order: LORICATA.

Crocodiles.

Family: CROCODILIDAE.

Two species are included in the Western Australian fauna, the one being the widely distributed *Crocodilus porosus,* known as the Estuarine or Saltwater Crocodile, the other the harmless fish-eating *Crocodilus johnstoni,* or Freshwater Crocodile, which is confined to the rivers of Northern Australia from Kimberley in the west to North Queensland in the east. Neither species seems to stray as far south as the De Grey, for I have had no reports of their presence south of the 20th parallel.

Crocodilus porosus, Schneider Hist. Amph. II., 1801, p. 159. Kimberley, estuaries and lower reaches of the rivers.

Crocodilus johnstoni, Krefft. Proc. Zool. Soc., 1873, p. 335.* Kimberley, apparently confined to freshwater.

Key to the Species

A.—Size larger, snout broader, post occipital scutes usually absent ; if present, small and irregular .... *porosus.*

B.—Size smaller, snout slender, four oval scutes in a transverse row behind the occiput .... *johnstoni.*

Order: SQUAMATA.

Sub-order: SERPENTES.

(Snakes.)

Snakes are widely distributed in Western Australia, and are to be found in various types of environment. The Sea-Snakes, *Hydrophiidae,* usually prefer warmer waters of the ocean, whilst the Tree-Snakes and Freshwater Snakes, *Colubrinae, Homalopsinae,* and *Dipsadinae,* do not appear to range beyond the limits of the administrative Kimberley Division. On the other hand, the *Boidae* and the *Elapidae* range from the Drysdale River in the north to the islands off the south coast; they are to be found in the wettest part of the South-West, and can carry on the unequal struggle for existence that is continually being waged in the far interior. In all, 56 species are accepted as constituting a portion of the indigenous fauna of Western Australia; some of them are found practically throughout the State, others are extremely local, for the records in the Museum would

* Owing to an error the name appears *johnsoni.*

suggest that *Furina calonota* does not exist 20 miles away from the Perth Town Hall, though relatively fairly common in the suburbs and at Guildford.

Key to the Families and Sub-Families.

A.—Tail very short, rounded, animal worm like .... *Typhlopidae.*

B.—Tail compressed, paddle-shaped, animal aquatic.... .... *Hydrophiidae.*

C.—Tail normal, longer or shorter, tapering.

A1.—Vestiges of hind limbs present .. .. *Boidae.*

B1.—No traces of hind limbs.

A2.—No poison fangs .. .. *Colubrinae.*

B2.—Poison fangs posterior .... *Homalopsinae* and *Dipsadinae.*

C2.—Poison fangs anterior .... *Elapidae.*

Family: TYPHLOPIDAE.

The *Typhlopidae* or Blind Snakes are burrowing snakes, which have the whole body covered with uniform scales; they seem to be the last living descendants of rather archaic snakes, once cosmopolitan in distribution, which have undergone degradation as the result of their adaptation to a burrowing life and a more or less completely insectivorous diet. They are cryptozoic, living underground, under stones, logs or termitaria, and feeding largely upon white ants, other insects, and worms. Only two of our species, *T. kenti* and *T. labialis,* have so far not been recorded from outside Western Australia. The Australian species have been monographed by the late E. R. Waite, F.L.S.

Typhlops gryphus, Waite, Rec. S. Aust. Mus. I., No. 1., 1918, p. 17, fig. 7. Marble Bar, Tambrey Station.

Typhlops kenti, Boulenger, A.M.N.H. (8). XIV., 1914, p. 482. Kimberley, Ashburton, De Grey.

Typhlops affinis, Boulenger, A.M.N.H. (6), IV., 1889, p. 363. Kimberley.

Typhlops guentheri (Peters), Mon. Akad. Wiss, Berlin, 1865, p. 259, fig. 1. Marble Bar.

Typhlops pinguis, Waite, Trans. R. Soc., S. Aust. XXI., 1897, p. 25, pl. III.

(Waite remarks "The headquarters of the species seems to be the extreme south-western corner of the Continent." It also occurs in South Australia and Victoria.)

Typhlops broomi, Boulenger, A.M.N.H. (7), II., 1898, p. 414. Kimberley, Norseman.

Typhlops wiedii (Peters), Mon. Akad. Wiss., Berlin, 1867, p. 24. Kimberley, South-West, Gingin.

Typhlops bituberculatus (Peters), Mon. Akad. Wiss., Berlin, 1863, p 233. Fortescue River and southwards.

Typhlops australis, Gray, Cat. Liz., B.M., 1845, p. 135. Southern Western Australia, Fraser's Range, Rottnest.

Typhlops waitii, Boulenger, Proc. Linn. Soc., New South Wales (2), IX., 1894, p. 718. North-West Australia. Waite considers this may be a synonym of *T. australis.*

Typhlops labialis, Waite, Rec. S. Aust. Mus I., pt. I., 1918, p. 30, fig. 22. "Western Australia" in Western Australian Museum.

Typhlops diversus, Waite, Proc. Linn. Soc., New South Wales (2), IX., 1894, p. 10, pl. I., figs. 4-6. Kimberley, Montebello I.

Key to the Species (after Waite).

A.—Nasal cleft in contact with the first labial ... *Typhlops gryphus.*
B.—Nasal cleft in contact with the second labial.
A1.—18 scales round the body.
A2.—Snout angular, nasal divided.
A3.—Rostral produced in front, snout acute .... *kenti.*
B3.—Rostral not produced .... *affinis.*
B2.—Snout rounded, nasal not divided .... *guentheri.*
B1.—20 scales round the body.
C2.—Head rounded.
C3.—Body stout ... . *pinguis.*
D3.—Body slender.
A4.—Nasal completely divided .... *broomi.*
B4.—Nasal not completely divided *wiedii.*
D2.—Head trilobed .... *bituberculatus.*
C1.—22 scales round the body, nasal cleft not produced on to the upper part of the head .... *australis.*
D1.—24 scales round the body .... *labialis.*
C.—Nasal cleft in contact with the preocular, 20 scales round the body .... *diversus.*

Family: BOIDAE.

This widely distributed family is represented in Western Australia by three genera, *Liasis, Python,* and *Aspidites,* all of them readily distinguished from our other snakes by the large number of rows of scales around the body, which always exceeds 40. *Python* ranges from Kimberley in the north to the South Coast. *Aspidites* and *Liasis* do not extend quite as far south as the latitude of Perth.

Liasis childreni, Gray, Zool. Misc., 1842, p. 44. Kimberley, Tableland, Montebello Island to Moora.

Liasis fuscus (Peters), Mon. Akad. Wiss., Berlin, 1873, p. 607. Kimberley.

Liasis olivaceus, Gray, Zool. Misc., 1842, p. 45, Kimberley, Pilbara.

Python variegatus (Gray), Zool. Misc., 1842, p. 43. Kimberley to South Coast.

Aspidites melanocephalus,* Krefft, Proc. Zool. Soc., 1864, p. 20, fig. , Kimberley Tableland, North Wheat Belt, Burracoppin.

Aspidites ramsayi, Macleay, Proc. Linn. Soc., New South Wales, VII., 1882, p. 813. Geraldton to Meckering.

Key to the Species.

A.—Premaxillary bone toothless, labials not pitted, subcaudals mostly single, scales in 53 rows—genus .... *Aspidites.*
A1.—Approximately ventrals 330, subcaudals 64 .... *melanocephalus.*
B1.—Approximately ventrals 293, subcaudals 52 .... *ramsayi.*
B.—Premaxillary bone toothed, subcaudals mostly divided.
C1.—Rostral with, or without, shallow pits.
A2.—Lower labials pitted, nostril supero-lateral in a semi-divided nasal—genus .... *Liasis.*
A3.—Several small loreal shields, rostral not pitted, scales in (approx.) 41–45 rows, V. 257–287, Sc. 38-54 *childreni.*
B3.—Single large loreal, rostral not pitted, two pairs of prefrontals.
A4.—Scales in (approx.) 47–49 rows, V. 275–291, Sc. 65–72 *fuscus.*
B4.—Scales in (approx.) 69-75 rows, V. 349-361, Sc. 100-102 .... *olivaceus.*
D1.—Rostral and anterior upper labials deeply pitted, tail prehensile—genus .... *Python.*
B2.—Crown covered with scales or small irregular shields, 2 or 3 upper labials pitted, subcaudals more than 50 .... *variegatus.*

* The distinctions between the two species of *Aspidites* have not yet been placed on a satisfactory basis, all the forms may represent one very variable species.

Family: COLUBRIDAE.

Sub-Family: COLUBRINAE.

The genus *Dendrophis* is the sole representative of the sub-family in Western Australia, this Green Tree Snake is confined to the Kimberley District: in the Eastern States its range extends southwards to Victoria. The Gren Tree Snake is harmless to man.

Dendrophis punctulatus (Gray), in King's Voyages II., 1827, p. 432. Kimberley.

Sub-Family: HOMALOPSINAE.

The members of this sub-family are thoroughly aquatic, bringing forth their young alive in the water. They inhabit Southern China, the Malayan Islands, Papuasia, and Northern Australia, and are represented in the Kimberley district by the genera *Cerberus* and *Fordonia*. *Myron* probably occurs there also, but its presence has not yet, as far as I am aware, been confirmed by specimens collected within the boundaries of the State.

The nostrils of the species are valvular and placed on the upper surface of the snout.

Cerberus australis (Gray), Zool. Misc., 1842. p. 65. Drysdale River, Kimberley.

Fordonia leucobalia (Schl). Phys. Serp II., 1837, p. 345, pl. XIII. Figs. 8. and 9. Drysdale River, Kimberley.

Sub-family: DIPSADINAE.

This widely distributed group is represented in Western Australia by a single species, *Boiga fusca*, the Brown Tree Snake. The nostrils are lateral and the dentition is well developed, the head is flat, triangular, and very distinct from the neck, the tail is long. The exact position of "*Dipsas ornata*" Macleay, does not seem to have been definitely settled, this Kimberley snake is therefore omitted.

Boiga fusca (Gray), Zool. Misc., 1842, p. 54. Kimberley.

Key to the Western Australian Colubridae.

A.—Nostril on the upper surface of the snout.

A1.—Nasals in contact behind the rostral .... *Cerberus australis.*

B1.—Nasals separated by an internasal .... *Fordonia leucobalia.*

B.—Nostril lateral.

C1.—Anal divided .... *Dendrophis punctulatus.*

D1.—Anal undivided .... *Boiga fusca.*

Family: HYDROPHIIDAE.

The Sea Snakes have become highly specialised because of their exclusively aquatic life. They are of comparatively recent origin, and are all poisonous, some of them being regarded as dangerous to human life. Their body is more or less compressed behind, and the tail is strongly compressed and paddle-shaped. In most of them the ventral shields are much reduced in size, being at times no larger than the scales of the sides and back. Ten species representing six genera are known to occur in Western Australia; as a rule they are confined to northern waters, but odd specimens may stray beyond these limits. *Pelamis platurus* is frequently cast up on the ocean beaches in the vicinity of Fremantle after winter storms, and has been recorded from Foul Bay, near Dermark, on the South Coast (March, 1928). The Museum possesses a single specimen of *Hydrophis elegans* caught near Busselton in 1913.

Aipysurus tenuis, Lonnberg and Andersson, Kungl. Sv. Vet. Ak., Handl. 52, No. 3, 1913, p. 13. 180 m. W.S.W. of Cape Jaubert, South of Broome.

Aipysurus laevis, Lacepede, Ann. Mus. Hist. Nat. IV., 1804, pp. 187, 210, pl. LVI., fig. 3. 180 m. W.S.W. of Cape Jaubert, South of Broome.

Hydrelaps darwiniensis, Boulenger, Cat. Sn. B.M. III., 1896, p. 270, pl. XII. Kimberley, Shark Bay.

Hydrophis kingi, Boulenger, Cat. Sn. B.M. III., 1896, pp. 276, 180 m. W.S.W. of Cape Jaubert, South of Broome.

Hydrophis elegans (Gray), Zool. Misc., 1842, p. 61. Geographe Bay, Bernier Island., 180 m. W.S.W. of Cape Jaubert, Kimberley.

Hydrophis major (Shaw), Gen. Zool. III., 1802, p. 363, and fig. . Bernier Island, Nicol Bay, Ninety-Mile Beach, Broome, Kimberley.

Hydrophis ornatus (Gray), *ocellatus* (Gray). Cat. Sn. B.M., 1849, p. 53. Broome (Cape Jaubert) = *Disteira mjobergi* of L. and A.

Acalyptophis peronii (Dumeril), Mem. Acad. Sci., Paris, 23, 1853, p. 522. Ninety-Mile Beach, Broome, Kimberley.

Astrotia stokesii (Gray), in Stokes' Discov., Aust. I., 1846, p. 502, pl. III. Port Hedland, Indian Ocean, Port Walcott, Kimberley.

Pelamis platurus (Linne), Syst. Nat. XII., ed. 1766, p. 391. Widely distributed; found as far south as Foul Bay (Denmark) on the South Coast.

Key to the W.A. Species (after Smith).

A.—Ventrals large, $\frac{1}{3}$ to $\frac{1}{2}$ the width of the body.

A1.—Scales in 19 rows, ventrals 187–192 ... ... *Aipysurus tenuis.*

B1.—Scales in 21 to 23 rows, ventrals 140–154 ... *Aipysurus laevis.*

B.—Ventrals small, not more than $\frac{1}{4}$ the width of the body.

C1.—Ventrals small, distinct throughout, normally undivided.

A2.—Headshields normally regular, nasals in contact.

A3.—No preocular ... ... *Hydrelaps darwiniensis.*

B3.—Preocular present

A4.—Scales on the thickest part of the body more or less hexagonal or quadrangular, feebly imbricate or juxtaposed, body spotted ... *Hydrophis ornatus ocellatus.*

B4.—Scales on the thickest part of the body with rounded or bluntly pointed tips, distinctly or feebly imbricate.

A5.—Three maxillary teeth behind the poison fangs, head entirely black ... ... *Hydrophis kingi.*

B5.—6 or 7 maxillary teeth behind the poison fangs.

A6.—Ventrals, 345–432 ... ... *Hydrophis elegans.*

B6.—Ventrals, 230–266 ... ... *Hydrophis major.*

B2.—Head shields more or less divided.

C3.—Nasals in contact, ocular shields with spinous borders ... ... *Acalyptophis peronii.*

C.—Ventrals except quite anteriorly, either divided by a median longitudinal fissure, or vestigeal (smaller than the adjacent dorsal scales).

D1.—Head large, body short and stout, yellowish or pale brown with darker cross bands or bars and ventral spots ... ... *Astroia stokesii.*

E1.—Head narrow, snout elongate, body much compressed, blackish above, yellowish below, tail yellow with blackish markings and spots ... *Pelamis platurus.*

Family: ELAPIDAE.

This family, which is very widely distributed in the warmer regions, is well represented in Australia, where it supplies the majority of the indigenous species. About thirty are known to occur in this State, including some that are peculiar to it.

Pseudelaps diadema (Schlegel), Phys. Serp. II., 1837, p. 32. Kimberley.

Demansia psammophis (Schlegel), Phys. Serp. II., 1837, p. 155. Kimberley, Pilbara, Bernier Island, Perth, Northam, South-West.

Demansia olivacea (Gray), Zool. Misc., 1842, p. 54. Kimberley.

Demansia modesta (Gunther), A.M.N.H. (4) IX., 1875, p. 35, pl. III., fig. C. Pilbara, Gascoyne River, Laverton, Geraldton, Perth, South-West, Wheat Belt, Kalgoorlie.

Demansia nuchalis (Gunther), Cat. Sn., 1858, p. 227.* Kimberley, Pilbara, Bernier Island, Dorre Island, Rottnest, Perth, South-West, Wheat Belt, Goldfields.

Pseudechis darwiniensis. Macleay, P.L.S., New South Wales, II., 1878, p. 220. Kimberley, Drysdale River.

Pseudechis australis (Gray). Zool. Misc., 1842, p. 55. Perth District, Goldfields, Yilgarn, Fraser Range, South-West.

* This is a very variable species both as regards scale characters and coloration. It seems impossible to regard *D. affinis* as specifically distinct, for intermediate forms are frequently met with, particularly in the South-West.

Pseudechis denisonioides, Werner, Fauna S.W. Aust., II., pt. 16. 1909, p. 258. Eradu, Dorre Island.

Denisonia coronata (Schlegel), Phys. Serp. II., 1837, p. 454. Southern Western Australia east to Esperance, Muchea, North Perth, Tambellup.

Denisonia coronoides (Gunther), Cat. Sn., 1858, p. 215. Mondrain Island.

Denisonia punctata, Boulenger, Cat. Sn. B.M., III., 1896, p. 341, pl. 18, fig. 4. Kimberley.

Denisonia gouldii (Gray), in Grey's Travels II., 1841, p. 444, pl. V., fig. 1. Widely distributed in Southern Western Australia, Sandstone, Perth, Norseman.

Denisonia maculata, Steindachner, Novara Rept., 1867, p. 81.* Pilbara, Murchison, Southern Cross, Bruce Rock.

Notechis scutatus (Peters), Mon. Ak. Wiss, Berl., 1861, p. 690. Kimberley, Perth, Garden Island, Albany District, Esperance, Stirling Range.

Brachyaspis curta (Schlegel), Phys. Serp. II., 1837, p. 486. North-West, Muchea, Perth District, Denmark, Albany, Laverton, Warriedar Station.

* Includes *D. ornata* (De Vis) and *D. fasciata* Rosen.

Acanthophis antarcticus (Shaw), Nat. Misc., pl. 535, 1794. Kimberley, Pilbara, Coolgardie, Perth District, Armadale, Eucla, North Twin Peak Island.

Acanthophis pyrrhus, Boulenger, A.M.N.H. (7) II., 1898, p. 75, Kimberley, Pilbara, Mullewa, Kalgoorlie, Bunjil, *via* Caron.

Elapognathus minor (Gunther), A.M.N.H. (3) XII., 1863, p. 362. South-West Australia. (B.M.)

Rhynchelaps bertholdi (Jan), Rev. et. Mag. Zool, 1859, p. 123. Kimberley, Pilbara, Carnarvon, Geraldton, Murchison, East Murchison, South-West, Kalgoorlie District, Balladonia, Dorre Island, Bernier Island.

Rhynchelaps semifasciatus (Gunther), A.M.N.H. (3) XI., 1863, p. 21, pl. III., fig. B. South-West, Perth District, Dowerin, and Watheroo.

Rhynchelaps fasciolatus, Gunther, A.M.N.H. (4) IX., 1872, p. 34, pl. V., fig. B. Carnamah, Laverton, Perth District.

Furina occipitalis (Dum. and Bibr), Erp. Gen. VII. 1854, p. 1220, Kimberley, Pilbara, Swan River.

Furina bimaculata, Dum. and Bibr, Erp. Gen. VII., 1854, p. 1240. Eastern Goldfields (Lake Side), South-West, Perth, etc.

Furina calonota, Dum. and Bibr, Erp. Gen. VII., 1854, p. 1241, pl. 75B. Vicinity of Perth, Wanneroo, Guildford, Leederville, Subiaco.

Key to the Species.

A.—Scales in 15 rows.
  A1.—Anal and subcaudals divided.
    A2.—Ventrals less than 140.
      A3.—Subcaudals less than 26 .... *Rhynchelaps bertholdi.*
      B3.—Subcaudals more than 28 .... *Furina calonota.*
    B2.—Ventrals more than 160.
      C3.—Subcaudals less than 30.
        A4.—Five upper labials .... *Furina bimaculata.*
        B4.—Six upper labials .... *Furina occipitalis.*
      D3.—Subcaudals more than 40.
        C4.—Subcaudals less than 65 .... *Pseudelaps diadema.*
        D4.—Subcaudals more than 65.
          A5.—Rostral nearly as deep as broad .... *Demansia psammophis.*
          B5.—Rostral much broader than deep.... .... *Demansia olivacea.*

  B1.—Anal and subcaudals not divided.
    C2.—Ventrals less than 130 .... *Elapognathus minor.*
    D2.—Ventrals more than 135.
      E3.—Subcaudals less than 35.
        E4.—Frontal $1\frac{3}{4}$ as long as broad *Denisonia punctata.*
        F4.—Frontal not $1\frac{1}{2}$ as long as broad .... *Denisonia gouldii.*
      F3.—Subcaudals more than 35.
        G4.—Large, blackish above and barred, yellowish below .... *Notechis scutatus.*
        H4.—Small, olive or brownish above with dark streak on each side of head.
          C5.—A black cross band on the nape .... *Denisonia coronata.*
          D5.—No black cross band on the nape .... *Denisonia coronoides.*

B.—Scales in 17 or more rows.
C1.—Scales in 17 rows.
E2.—Anal divided.
G3.—Subcaudals all divided.
J4.—Subcaudals more than 54 .... *Demansia nuchalis.*
K4.—Subcaudals less than 52.
E5.—Subcaudals more than 37 *Demansia modesta.*
F5.—Subcaudals less than 28.
A6.—Nasals in contact with preocular scale ... *Rhynchelaps semifasciatus.*
B6.—Nasals widely separated from the preocular .... *Rhynchelaps fasciolatus.*
H3.—Anterior subcaudals undivided.
L4. Frontal nearly twice as long as broad .... *Pseudechis australis.*
M4. Frontal as broad as long .... *Pseudechis darwiniensis.*
F2.—Anal undivided.
J3.—Posterior subcaudals divided ... *Pseudechis denisonioides.*
K3.—Subcaudals all undivided.
N4.—Subcaudals more than 38 .... *Notechis scutatus.*
O4.—Subcaudals less than 31 .... *Denisonia maculata.*
D1.—Scales in 19 or more rows.
G2.—Scales in 19 rows.
L3.—Anal and subcaudals divided .... *Demansia nuchalis.*
M3.—Anal and subcaudals undivided.
P4.—Subcaudals more than 38 .... *Notechis scutatus.*
Q4.—Subcaudals less than 36 .... *Brachyaspis curta.*
H2.—Scales in 21 or 23 rows.
N3.—One pair of prefrontals, colour dull brown ... . *Acanthophis antarcticus.*
O3.—Two pairs of prefrontals, colour reddish .... *Acanthophis pyrrhus.*

In *A. antarcticus* the head scales are less rugose, and the dorsal scales on the body much less strongly keeled than in *A. pyrrhus*. A specimen of the former species from the Recherche Archipelago has divided prefrontals.

It will be noticed that certain variable species appear several times in the above key.

By Authority: FRED. WM. SIMPSON, Government Printer, Perth.

8.—CONTRIBUTIONES FLORAE AUSTRALIAE OCCIDENTALIS VII.

(With Three Plates II.-IV.)

By

Charles A. Gardner, Department of Agriculture.

(Read 12th June, 1928; Published 18th June, 1928.)

Philotheca miniata, Gardner, n. sp. (Plate II.)

Frutex ramosus, ramis numerosis divaricatis. Foliis crassis, linearibus-clavatis, glanduloso-verrucosis subtiliter velutinellis, demum glabris; floribus breviter pedunculatis, 1-3 terminalibus; sepalis late orbicularibus, pubescentibus, valde inaequalibus, marginibus ciliolatis; petalis miniatis, oblongo-ovatis; synandrium violaceo-pilosum; staminodiis pilosis, carpellis pauce tomentosis, obtusis; stylo alte immerso e longe exserto.

Frutex circ. 2m. altus; folia 10–15mm. longa, sepala variabilia ad 9mm. longa, petala 2·1 cm. long.; synandria 2·7 cm.; stylus 3·0 cm.

Hab. in distr. Austin prope Cue, in rimosis lapidosis collibus, fl.m. Jun. Jul. (C. A. Gardner, Jul. 1927. Granite plateau east of Cue, W. D. Campbell, Jun. 1902.)

This species is certainly very closely related to *P. ericoides* (Drumm. et Harv.) F. v. M. It is, however, a much larger shrub with strongly divaricate branches leafy only on the ultimate twigs, and may be further distinguished as follows:—The leaves are larger and more clavate, white tomentose unless very old, with a broad apical reddish gland. The flowers are much larger. The calyx is composed of very unequal sepals which are usually broader than long, dark in colour, but concealed beneath a close white tomentose pubescence. The petals are similar in shape to those of *P. ericoides*, but are an intense orange-cinnabar in colour, and are ciliate in the upper half. The staminal tube is a rich scarlet in colour becoming violet upwards, and the tips of the staminodes are glabrous but concealed within the intricate hairs which envelop the tube. The carpels are tomentose on their inner faces.

Philotheca ericoides is insufficiently described in Bentham's Flora Australiensis. It is known only from the slopes of White Peak, a prominent hill to the north of Champion Bay. This plant, of which only a small colony is known, is 1 to 2½ feet in height, with strictly erect branches, the perfectly glabrous leaves being crowded along the branches. The sepals are ovate, more or less equal, and entirely glabrous. The petals are yellowish-white, rather prominently keeled, and quite glabrous. The staminal tube is white in the lower half, and violet above. The carpels are quite glabrous, and the staminodes are hairy to their extremities. The flowers are about two-thirds the size of those of *P. miniata*.

A variation in colouring is known in *P. Hassellii*, another closely related species of the eastern sand heaths. Although the petals are normally yellow, red-flowered forms are known, particularly towards the western boundary of its habitat. In contrasting *P. ericoides* and *P. miniata*, however, we have

an extraordinary difference in habit, leaf arrangement and vestiture, and in the indumentum of the flowers. The structural differences are confined to the calyces, and, to a less extent, to the leaves.

Darwinia carnea, Gardner, n. sp. (Plate III. A-G.)

Fruticulus ramosus dilatatus, ramulis divaricatis. Foliis congestis, oppositis, decussatis, glabris, coriaceis, lineari-lanceolatis, carinatis, apice acutis. Capitulis globosis amplis nutantibus; receptaculo glabro. Involucri phyllis amplis ovatis glabris obtusis, flavo-carneis, persistentibus. Bracteolis late linearibus acutis, supra concavis; calycis-tubo cylindrico exsulco, indurato, laevi, lobis brevissimis suborbicularibus; petalis albis ovato-lanceolatis, obtusis, calycis lobis triplo longioribus; antheris globosis; staminodiis lineari-spathulatis, apice nigro-glandulosis, stylo sub apice conspicue barbato. Ovula 2.

Fruticulus 20–30 cm. altus. Folia·6 -1·0 cm. longa, 1—1·3mm. lata; Bracteae ad 3 cm. long. Calycis tubus 4mm. altus, ad 2mm. latus, lobi ca 1·5mm. longi ac lati.; petala 4mm longa, 1·6mm. lata. Stamina 1·5mm. longa; stylus 13·5mm.

Hab. in distr. Avon septentrionali inter Mogumber et Nova Norcia, in collibus glareosis, fl. mens. Decemb. (C. A. Gardner, 1385.)

This new species belongs to those species of the Sect. Genetyllis which have drooping heads with the involucral bracts coloured and longer than the flowers which they enclose. The concave keeled leaves place it next to *D. speciosa*, from which it is very different. The involucres are not the same reddish green colour; there are many more flowers in the head. The calyx-tube is not ribbed, and the lobes obtuse and very much shorter. There are several other important differences, such as the length of the bracteoles and the acute, not obtuse, leaves. There is also a resemblance to *D. acerosa* W. V. Fitz., but the organs are all very much larger, and the type of inflorescence is different.

Cryptandra connata, Gardner, n. sp. (Plate III. H-L.)

Frutex divaricato-ramosissimus, ramis primariis erectis, secundariis late patentibus, ramulis spinescentibus. Foliis fasciculatis, linearibus vel lineari-lanceolatis, omnino revolutis, subacutis vel obtusis, supra glabratis subtus albo-pubescentibus. Bracteis latissimis, fuscis, glabris, marginibus ciliolatis, calycis tubo brevioribus. Calycis tubo glabro, ovoideo-conico, basi inflato, e lobis erectis, apice acutis ipso pauce barbatis, utrinque glabris; petalis minutis, unguiculatis cucullatis, calycis limbi semiaequantis; disco crassiusculo ad basin ovarii; ovario hirsuto; stylo elongato trifido.

Frutex 2—3m. alt.; folia 2—3mm. long.; bracteae circ. 2·5mm. long.; calyx 5·5—6·5mm.long.; lobi 2mm. long.; petala ·8mm. long.

Hab. in distr. Austin prope Sandstone, in apertis lutosis flor. mens. Jul. (C. A. Gardner, July, 1927.)

The new species, belonging to the Section *Wichurea* (*Wichurea*, Nees), shows also some points of similarity with *Discaria*. It is large for a Western *Cryptandra*, and its diameter exceeds its height. The branches are widely spreading and intricate, the whole shrub forming a dense impenetrable mass of up to 10 feet in diameter; the short alternate branchlets terminate in thorns. The small heath-like leaves appear to vary considerably in shape and size, from linear to lanceolate, from sub-acute to very obtuse, but all have closely revolute margins. The flowers are remarkable for the genus, in that the calyx-lobes are erect and closely connivent and never expand.

In this character the flower reminds one somewhat of *Conostephium*. The acute calyx-lobes are shortly bearded at the apex. The small hood-shaped petals have slender claws, and quite conceal the anthers. The disc is basal, with the ovary slightly immersed in it. The ovoid ovary is hirsute or pilose with long spreading hairs except the upper third which is glabrous, and the slender glabrous style has a three-lobed stigma. In its connivent or almost connate calyx-lobes the new species would appear to differ from any other species known, as far as I can ascertain. This character gives the flower an ovoid-conical shape. It appears to be related to *C. arbutiflora*, but is perhaps best placed immediately following *C. nudiflora*. The flowers are of two colours, and appear to be constant in the individual plants: one is pure white, and the other a claret-coloured purple.

Melaleuca Steedmanii, Gardner, n. sp. (Plate III. M-O.)

Frutex ramosus divaricatus. Foliis oppositis glaucescentibus tenuiter coriaceis, glanduloso-punctulatis, obovatis vel oblanceolato-oblongis, apice interdum recurvo, plus minusve obtusis, basin versus in petiolulum angustatis, uninerviis. Floribus ad basin ramulorum lateralium insertis, spicam brevem formantibus; ramulis apice foliis novellis portantibus; calycis tubo glabro, urceolato, basi dilatato, rhachi inserto, e lobis hemisphaericis rotundis; petalis purpureis concavis, suborbicularibus, diffusis, ex ungue brevilato; phalangibus purpureis polyandris, unguis petalorum brevioribus, filamentis erectis densibus; stylo crasso, stigmate peltato; fructu sessile late urceolato, lobis persistentibus.

Folia 12—18mm. longa, 2·5 -3·5mm. lat. Calycis tubus 4mm. alt., 6mm. lat., lobi 3 × 4mm.; petala 10mm. long., 7mm. lat.; phalangia 13mm. long; stylus circ. 1·5cm. long.; fructus circ. 9mm. diamet.

Hab. in distr. Irwin a Watheroo septentrionem versus, fl. m. Sept.-Oct. (H. Steedman, Septem. 1926.)

Apparently a large divaricately branched shrub. Leaves opposite, obovate or oblanceolate-oblong, not linear, very shortly petiolate, black-dotted with fine spots, not glandular-dotted, rather thick, blue-green, flat or the margins incurved, the midrib alone prominent. The flowers are in short loose spikes at the base of the smaller branchlets, already leafy when the flowers expand. The large and conspicuous flowers are an intense crimson, and the petals very concave. The staminal bundles are rather large, but the claws are shorter than the petals, and the filaments are numerous, and mostly inserted on the inner faces of the bundles. A few are marginal. The fruit is widely urceolate, five-angled, with the thickened parts of the calyx-lobes persistent.

This species is very close to *Melaleuca fulgens* in the floral structure, but the staminal bundles are shorter, not exceeding seven lines in length, and the position of the filaments is different, besides being smaller, they are erect from the spreading bundles, and crowded along the inner faces. The fruit is similar in some respects, but is much smaller, with five distinct faces on the sides, and the lobes are persistent. The leaves are entirely different.

It is equally close to *M. radula* which it much resembles in everything but the colour of the flowers, although here again the leaves are very different, and the filaments are fewer, and the calyx-lobes of the fruiting specimens are a further distinction. The seeds appear to be more those of *M. radula* than of *M. fulgens*. Although the flowers are red, and the bundles about half an inch long, this species, on account of its stamens, should be placed near *M. radula*.

I have named this species after Mr. H. Steedman, of the Zoological Gardens, Perth, whose untiring enthusiasm has been responsible for the introduction of several of our little known plants into cultivation.

Eucalyptus Carnei, Gardner, n. sp. (Plate IV.)

Arbor robusta ad 10 m. elata, e cortice nigro-tessellata ad basin, vulgo "Blackbutt" nuncupata, supra cinereo-dealbata, ramis laxis, pendulis, ramulis primum glaucis demum lucido rubris. Foliis primariis non visis. Foliis maturis alternis subfalcatis, crassis, subopacis, utrinque glaucentibus. Floribus 6 vel 7 sessilibus umbellatis. Pedundulis crassis, cuneatis, albido-cinereis, circiter tam amplis quam longis; calyce oblongo-turbinato sive truncato-ovoideo tenuiter compresso, duabus strictis oppositis costis habente, et minus conspicuis duabus costis intermediis, tubo calycis fere duplo majori quam operculum; operculo ovoideo-hemispherico obtuso; staminibus maturis ignotis, pallidis, inflexis, antheris longitudinaliter aperientibus; fructu cylindrico truncato, longitudinaliter corrugato, fusco non lucido, margine elevata, albineante, valvis plus minusve inclusis.

Caulis 30–40cm. diamet.; petiolus 1·4—2·0 cm.; lamina 8·0—11·0 cm. longa, 1·3—2·2 cm. lata.; pedunculus 1·2—1·3 cm. long., 8—9mm. lat.; calycis tubo 6—7mm. long.; 4·5—5mm. diamet.; operculo 4—4·5mm. long.; fructu 6mm. long., 6mm. lat.

Legi mense Julio 1927, in distr. Austin prope Sandstone, in collibus lapidosis, fl. mense (?) Aug. (C. A. Gardner.)

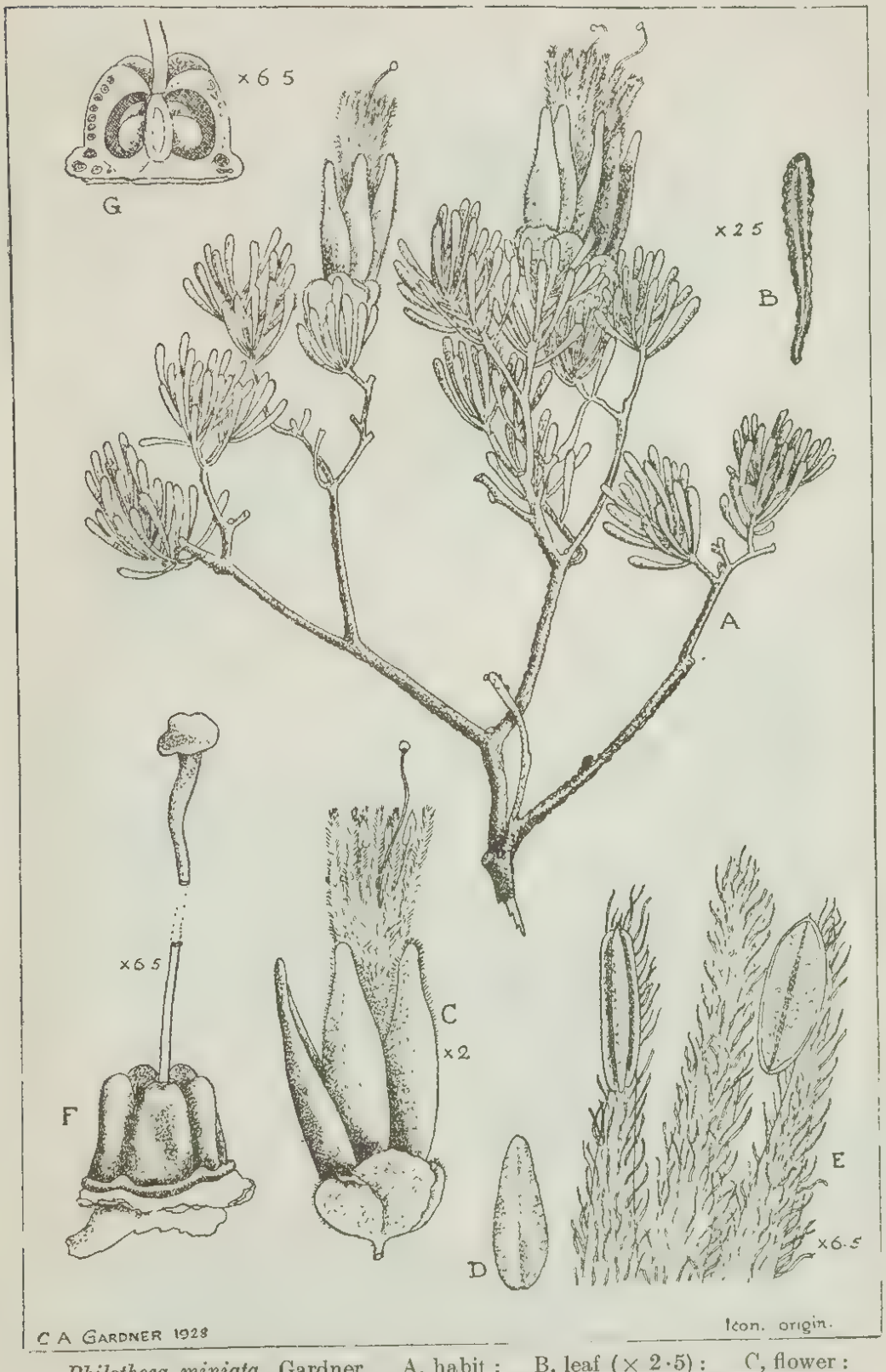
The new species is a typical Blackbutt of 20-30 feet in height, with a stout trunk tessellated at the base, the upper portions of the trunk and the branches being smooth and ashy-white in colour, occasionally warming to a yellow tint. The branches are spreading, and the glaucous angular branchlets are almost pendulous The timber is a deep yellow-brown in colour, tough and dense. Occurring well within the territory of the Mulga Bush where Eucalyptus is very rare, this tree is a striking object in its habitat.

The glaucous angular branchlets, thick and wide peduncles, green-brown calyx-tube and warm orange operculum, together with the habit are vividly reminiscent of *Eucalyptus Stricklandi*, a species occurring far to the south, but the smaller unribbed operculum, and the very short perfectly straight sided and cylindrical fruit with included valves, render it quite distinct, among other features.

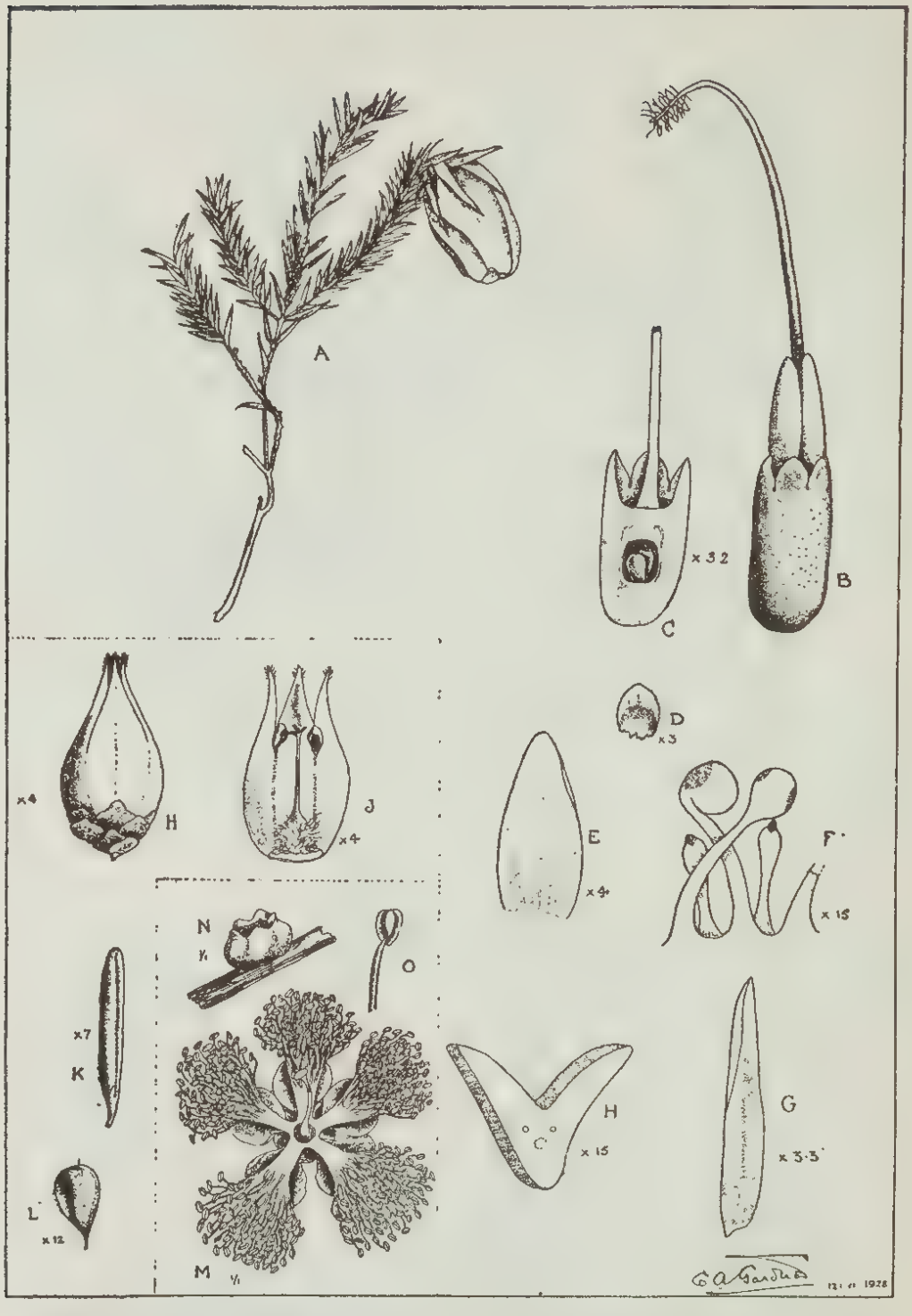
The species is perhaps most closely related to *E. dumosa*, a mallee common in the southern areas of Western Australia, and differs in the following characters: The much flattened and thick glaucous peduncle, strictly lateral umbels, glaucous angular branchlets, smooth and wide operculum, sessile calyces with opposite angles resembling narrow wings, and also in the fruit. The angular pyramidal seeds also appear to bear out this affinity.

There is also an affinity with *E. grossa*, but there are many points of dissimilarity.

I have named this species in honour of Mr. W. M. Carne, Botanist and Plant Pathologist to the Department of Agriculture, and the first botanist to hold the position of President of the Royal Society of Western Australia.



Philotheca miniata, Gardner. A, habit : B, leaf (× 2·5) : C, flower : D, petal, half natural size : E, details of stamens and staminodes : F, gynoecium : G, carpels in section (× 6·5).



Darwinia carnea, Gardner. (A—G). A, habit ($\frac{1}{2}$ nat. size): B, flower: C, section of calyx: D, calyx-lobe: E, petal: F, stamens and staminodes: G, leaf: H, section of leaf.

Cryptandra connata, Gardner. (H—L). H, flower: J, section through flower; K, leaf: L, petal.

Melaleuca Steedmanii, Gardner. (M—O). M, flower: N, fruit: O, stamen.

Eucalyptus ~~curvea~~ Carnei, Gardner. A, branchlet with buds: B, fruits: C, flower-buds: D, fruits.

By Authority: FRED. WM. SIMPSON, Government Printer, Perth.

LIST OF PUBLICATIONS

of the

ROYAL SOCIETY OF WESTERN AUSTRALIA.

With Names of **Authors** *and short titles of Papers.*

Journals and Proceedings.

Vol. I., 1914-1915.—**M. A. Browne**—Approximate summation of series **W. B. Alexander**—A new stomatopod—Further notes on stomatopods—History of zoology in W.A., part II.—Birds met by Vlaming on Swan River. **W. J. Dakin**—Marine biology in W.A.—Vitalism in modern biology. **H. B. Curlewis**—Tides. **E. S. Simpson**—Natrojarosite from Kundip **W. D. Campbell** Natives of Sunday Island. **C. Hedley**—Preliminary index of mollusca of W.A.

Vol. II., 1915-1916.—**A. Gibb Maitland**—Problems of Western Australian geology. **F. E. Allum**—Principles of currency. **J. T. Jutson** and **E. S. Simpson** Geology and physiography of Albany. **A. Montgomery**—Physiographical characteristics of Western Australia. **W. B. Alexander**—Orthopterous insects from W.A.—A new species of *Eroxymetopon*.

Vol. III., 1916-1917. **W. J. Hancock** X-rays. **W. B. Alexander**—History of zoology in W.A., Part III. **H. W. V. Talbot** and **E. de C. Clarke** Expedition to South Australian border. **A. D. Ross**—Gyrostatic action. **W. V. Fitzgerald**—Botany of Kimberleys.

Vol. IV., 1917-1918. **A. Montgomery** Closer application of science to industries. **F. E. Allum**—Decimalisation of British currency. **W. B. Alexander**—New species of marsupial. **W. J. Dakin**—W.A. pitcher plant.

Vol. V., 1918-1919 **W. J. Hancock**—Science and civilisation. **W. G. Woolnough**—Physiographic elements of Swan coastal plain. **J. S. Battye** Causes of colonisation of W.A. **W. Kingsmill**—Acclimatisation. **W. A. Saw**—Town planning. **A. R. L. Wright**—Houses in W.A.—**D. A. Herbert**—The W.A. Christmas tree. **A. D. Ross**—Light and the ether. **E. S. Simpson**—Hisingerite.

Vol. VI., Part I., 1919-1920—**J. L. Somerville**—Uplift in neighbourhood of Perth. **W. B. Alexander**—W.A. Lampreys Aboriginal names of animals—(With **C. E. Lane-Poole** and **D. A. Herbert**) Indigenous plants of economic importance **D. A. Herbert**—Climbing of waterfall by lampreys—*Xanthorrhoea reflexa*. **E. de C. Clarke**—Glaciated boulders near Leonora and Laverton. **E. Cheel**—New species of *Dariesia*.

Vol. VI., Part II., 1919-1920.—**G. L. Sutton**—Science and agriculture—Absorption of moisture by wheat. **D. A. Herbert**—Confusion between *Acacia cyanophylla*, *A. saligna* and *A. cyclops*—Contributions to flora of W.A. No. 1 *Proteaceae*, *Rutaceae*, *Polyporaceae*, *Phalloideae*. **E. S. Simpson** Cobaltiferous Epsomite. **S. K. Montgomery**—*Hymenosomidae* from Swan River. **J. Clark**—W.A. Ant-nest beetles. **E. Ashby**—Three species of *Stenochiton* from W.A.

Vol. VII., 1920-1921.—**E. S. Simpson**—Science and mineral industry Staurolite from Mogumber. **L. Glauert**—W.A. Petrels and albatrosses—Fish collected near Albany Pleistocene fossil vertebrates from Fitzroy River—Teeth of *Nototherium mitchelli*. **M. Aurosseau** and **E. A. Budge**—Terraces of Swan and Helena Rivers. **H. Bowley**—Chemistry of alunite. **D. A. Herbert** Contributions to flora of W.A., Nos. 2 and 3—Parasitism of the Quandong—Parasitism of the Sandalwood—*Xanthorrhoea* in W.A. **G. E. Nicholls**—*Dero roseola* (*naidiform worm*). **W. E. Shelton**—Xerophytism in Swan River district.

Vol. VIII., 1921-1922.—**F. E. Allum**—Modern currency problems. **G. L. Sutton**—Pedigree selection of wheat. **L. Glauert**—Contributions to Fauna of W.A., No. 1. **E. Ashby**—*Acanthopleura*. **D. A. Herbert**—Contributions to Flora of W.A., No. 4. **A. Cayzer** and **F. W. Wakefield**—*Darwinia pimelioides*. **R. D. Thompson**—Solar eclipse of September 21, 1922.

Vol. IX., Part I., 1922-1923. **R. A. Farquharson**—Impsonite in W.A.—Geology of Kalgoorlie. **C. A. Gardner**—Contributions to Flora of W.A., Nos. 1 and 2. **J. Clark**—New myrmecophilous beetle—Honey ants. **L. Glauert**—Cretaceous Echinid—Contributions to Flora of W.A., Nos. 2 and 3. **R. J. Tillyard**—Embioptera of W.A.

Vol. IX., Part II., 1923.—**E. de C. Clarke**—Pre-Cambrian in W.A. **R. Trumpler**—Structure of Sidereal Universe. **E. S. Simpson**—Secondary sulphates and chert in Nullagine Series. **T. H. Withers**—Cretaceous cirripede. **A. D. Ross** and **R. D. Thompson**—Energy involved in recent outburst of Beta Ceti. **E. O. G. Shann**—Foreign exchange. **J. Clark**—Australian Formicidae. **C. A. Gardner**—Contributions to Flora of W.A., No. 3. **L. W. Phillips**—Essential oils of some W.A. plants.

Vol. X., 1923-1924.—**W. H. Shields**—Sand Bars. **E. Cheel**—New myrtaceous plant. **L. Glauert**—Fossil plants from Mingenew and Irwin River—*Phreatoicus palustris*—Contributions to Fauna of W.A., No. 5. **E. Ashby**—New species of *Acanthochiton*. **A. D. Ross**—Einstein eclipse tests—Theories regarding the Æther. **G. E. Nicholls** and **D. F. Milner**—*Hyperoedesipus plumosus*. **G. E. Nicholls**—*Phreatoicus lintoni*—*Neoniphargus branchialis*. **W. E. Wood**—Increase of salt in soil and streams. **E. S. Simpson**—Coongarrite. **W. M. Carne** and **E. J. Limbourn**—Natural crossbreds in oats and barley. **J. Clark**—Australian Formicidae. **C. A. Gardner**—The so-called *Ericopsis formosus*.

Vol. XI., 1924-1925.—**F. W. Whitehouse**—Jurassic fossils from Western Australia. **T. H. Withers**—*Uintacrinus* in Australia. **C. A. Gardner**—New species of *Darwinia*—Naturalised plants of extra-tropical Western Australia. **A. Knapp**—Actinic value of light. **D. W. Everson**—Crystal receiving sets. **J. L. Reath**—Mollusca from sub-recent beds of Swan River. **W. M. Carne**—Census of plant diseases of South-Western Australia. **Chas. Chilton**—A new species of *Neoniphargus* from Western Australia. **E. Cheel**—"Blind Grass." **L. Glauert**—Australian Scorpionidea. Part I. **E. S. Simpson**—Japan. **A. D. Ross**—Variation of light intensity of corona—Science and industry. **D. A. Herbert**—Root parasitism of Western Australian *Santalaceæ*.

Vol. XII., 1925-1926. **R. J. Tillyard**—New spoon-winged lace-wing. **L. Glauert**—Gingin Chalk. **W. M. Carne**—Brown rot of citrus. **J. Clark**—Australian Formicidae. **L. F. Spath**—Ammonites from Gingin. **E. S. Simpson**—Contributions to mineralogy of W.A. **C. A. Gardner**—Contributions to flora of W.A., No. 5. **G. E. Nicholls**—*Protocrangonyx fontinalis*—*Neoniphargus obrieni*—New genus and species of Amphipods—*Crotena gellandi*—New genera and species of Phreatoicidea. **G. E. Nicholls** and **H. M. Barnes**—*Halonisceus stephensi*—Two new terrestrial isopods. **G. E. Nicholls** and **K. C. Richardson**—New species of *Acrotelsa*. **G. E. Nicholls** and **A. A. Jackson**—New species of *Megascolex*. **T. H. Withers**—*Marsupites* and a new cirripede from Upper Cretaceous of W.A. **E. de C. Clarke**—Natural regions in W.A. **E. de C. Clarke** and **F. A. Williams**—Geology and Physiography of parts of Darling Range. **A. Gibb Maitland**—W.A.'s contribution to Earth History. Brief descriptions of some exhibits.

Vol. XIII., 1926-1927.—**T. H. Maiden** and **W. F. Blakely**—Fifty new species and six new varieties of Western and Northern Australian Acacias. **E. S. Simpson**—Contributions to W.A. Mineralogy, Series ii. **H. W. Bennetts**—Helminths of Western Australian Stock, Series i. **Chas. A. Gardner**—Contributions to flora of W.A., Series vi. **A. D. Ross**—On the evolution of the new star "Nova Pictoris"—The Physical properties of Manganese steel. **A. Gibb Maitland**—Volcanic History of W.A.

INFORMATION REGARDING COMMUNICATIONS TO THE SOCIETY AND INSTRUCTIONS TO AUTHORS OF PAPERS SUBMITTED FOR PUBLICATION.

1.—Communications :

Communications to the Society at its General Meetings take the form of Papers, Notes, Demonstrations, Lectures, or Contributions to Special Discussions.

2.—Publications :

Communications announcing the results of original research, or collecting important information not easily accessible, or otherwise of special value to Western Australia, may be printed in the "Journal" in a form approved by the Society's Publication Committee.

3. -Reading of papers :

At meetings of the Society, papers may be announced for reading *in extenso*, in part, or (in cases of highly technical papers to be printed in the "Journal") only by title. In general, authors will find that the brief and concise statement which is the best form of paper for publication is unsuitable for verbatim reading at the meeting.

In order to secure adequate discussion at the meeting, and also to expedite publication, papers should be submitted in advance, as required by the Rules of the Society.

4.- -Manuscript :

Papers must be in a form suitable for publication, and complete when communicated to the Society, and should be as clear and concise as possible.

The copy of a paper intended for publication should be written on large sheets of paper, on one side only; the lines should be widely spaced, and the pages clearly numbered. The MS. must be easily legible, preferably type-written in double spaced typescript on sheets of ordinary thickness, uniform in size and must be absolutely in its final form for printing. In order to give room for editorial marking, etc., it is desirable to leave a margin of at least an inch at the top of the page, an inch at the left and not less than half an inch at the bottom. Drawings or photographs intended for use as illustrations, should be kept distinct from the text, not inserted in it, though transmitted at the same time. All references to plates or illustrations in the text, etc., must be in their proper places, and spaces must be indicated for the insertion of illustrations which are to appear in the text.

5.—Illustrations :

All illustrations must be in a form immediately suitable for reproduction. The size of the printed plate will not exceed 8 inches by 4¼ inches, and drawings may be of this size, or a convenient multiple of this to facilitate reduction. Plates to be folded may exceed the above limits, but must in all cases be a convenient multiple thereof. Text figures should be drawn for reduction to a width not exceeding that of the text page (8 inches by 4¼ inches) and at least a quarter of an inch shorter. Drawings to be reproduced as line blocks should be made with Indian ink, preferably on

fine white bristol board, free from folds or creases; smooth, clean lines, or sharp dots, but no washes or colours, should be used. If the drawings are done on a large scale, to be afterwards reduced by photography, any lettering or other legend must be on a corresponding scale. When reduction in a definite ratio is required, this must be clearly and specifically stated.

6.—ADDITIONS :

Additions to a paper after it has been finally handed in for publication, on acceptance by the Publication Committee, shall be treated and dated as separate communications, and may, or may not, be printed immediately after the original paper.

7.—PRINTING :

As soon as any paper has been accepted for publication, either in its original or in any altered form, it is sent to the printer in accordance with the Council's revised instructions as to the printing of papers.

8.—PROOFS :

A first proof, and, if necessary, a revise proof will be sent to the author, whose address should be indicated on the MS. No corrections other than those of printer's errors may be made without the express sanction of the Editor, and where corrections other than those of printer's errors are allowed, the cost shall be borne by the author. If proofs are not returned within one week from the date of issue, the Editor may at his discretion proceed with the printing of the paper, and in such case neither the Society nor any of its officers shall be responsible for any uncorrected errors in the printing. Authors of papers who live at a considerable distance from Perth should authorise someone in the metropolitan area to correct their proofs.

9.—AUTHOR'S COPIES :

Authors receive gratis 25 copies of their paper, and, at cost price, any additional number required, provided that the number of copies required is intimated to the Editor as soon as the paper is accepted for publication. Copies supplied to authors are not covered, but covers may be supplied at cost price on special request made at the time of ordering the reprints.

GENERAL INDEX

TO

THE JOURNAL

AND

PROCEEDINGS OF THE ROYAL SOCIETY.

By Authority: FRED. WM. SIMPSON, Government Printer, Perth.